A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

The SCIENCE COUNSELOR

Volume XVI ★ Number 4 ★ Dec., 1953

DUQUESNE
UNIVERSITY
PRESS

The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL *of teaching methods and scientific information especially for teachers of science in Catholic schools. Indexed in the Catholic Periodical Index. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

THE DUQUESNE UNIVERSITY PRESS

Subscription Price: $2.00 per year; Canada, $2.25. Single copies of issues in the current year, 60¢ each. Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh 19, Pa.

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Licorice—The Wonder Weed
By William W. Walker, President, MacAndrews and Forbes Company, New York City.

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An Alternative Course for Solid Geometry
By Sister M. Michael, Department of Mathematics, Mount Mercy College, Pittsburgh, Pennsylvania

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Blood Plasma Extenders
By Homer E. Stavely, Director, Pharmaceutical Research, Commercial Solvents Corporation, Terre Haute, Indiana.

Making a Frieze as a Science Activity for Sixth Graders
By Peter Vroom, Hibernia Public School, Hibernia, New Jersey.

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Torula Yeast
By John C. Garey, Manager, Special Yeast Products Division, Red Star Yeast and Products Company, Milwaukee, Wisconsin.

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Medical Technology for You
By Sister M. Edwin, Medical Technologist, Mercy Hospital, Pittsburgh, Pennsylvania.

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Cultivation of Food Plants in Dry Areas
By S. Duvdevani, Head, Dew Research Station, Karkur, Israel.

•

Personality Factors in Human Relations
By Anthony T. Oliva, Department of Psychology, Duquesne University, Pittsburgh, Pennsylvania.

Municipal Purchasing -- An Interesting Occupation

• By William Driscoll
DIRECTOR, DEPARTMENT OF SUPPLIES, CITY OF PITTSBURGH, PITTSBURGH, PENNSYLVANIA

This is another in the series of articles on unusual occupations we have been publishing from time to time.

Here you may learn how a large city buys the varied supplies for which it spends many millions of dollars each year.

Why does a city buy horse meat and cracked eggs? What does it do with ant eggs and dried flies? Why are fresh beef hearts and blood needed? Why does the rubbish collector use a burlap sheet?

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The responsibility for the purchase of all materials and supplies used by the several departments of the city of Pittsburgh rests with the Department of Supplies. No purchase may be made without authority of the Mayor and Council. All purchases must be carried through in strict accordance with the provisions of State law and the Ordinance of Council pertaining thereto. Every item purchased must be bought on bid, or on price contract previously entered into, and must be purchased from the lowest responsible bidder.

During the month of October, City Council, with the approval of the Mayor, enacts what is known as the General Ordinance, under the provisions of which the Department of Supplies is authorized to purchase materials and supplies requisitioned by the several departments of the city government. Upon approval of the General Ordinance, the Department of Supplies begins the job of purchasing for the coming year. Price contracts are entered into for the furnishing of milk, food and medical supplies for our two city hospitals, deliveries beginning early January 1st. Gasoline for the city garages, supplies for the pumping stations, police and fire stations and other operations that function continuously must be contracted for.

In a normal year the several departments will issue 10,000 requisitions on the Supplies Department. To provide the materials, supplies and equipment called for on these requisitions, we enter into approximately 700 contracts to cover items costing $500.00 or more, as well as the items usually obtained on an annual or price contract basis. To provide the supplies costing, in each instance less than $500.00, some 96,000 inquiries, or invitations to bid, go out by mail. Purchases under contract and on inquiry result in our writing approximately 12,000 orders annually. This is in addition to the orders on our warehouse stock. These orders, covering the needs of the city departments for supplies, materials and equipment, costing approximately $3,225,000.00 annually, go out not only to all sections of the United States but to many foreign countries as well.

In the course of a twelve months' period we buy for our hospitals, among other things, 100,000 pounds of bread, 175,000 pounds of meat, 19,000 pounds of butter and some 26,000 dozens of eggs. We expend thousands of dollars for furniture, bedding, drugs, biologicals and surgical supplies, plus paper towels, tray covers, napkins and other paper products by the carloads. The meat-eating animals in the city Zoo consume 78,000 pounds of horse meat. This we buy fresh, government inspected, at 15¢ per pound. The sea lion and other fish-eating animals consume, annually, 18,000 pounds of fish. For our city stables and the Zoo we buy 350 tons of hay and 8,500 bushels of oats. Certain animals do not thrive on ordinary clover or timothy hay but must have the more expensive alfalfa. In the interest of economy we buy large quantities of day-old bread for the Zoo and also, for this institution, cracked eggs at a saving of 20¢ per dozen.

A few years back we were faced with a shortage of beef and the patients in our two city hospitals were fed so much turkey they were delighted with a rib roast for Thanksgiving dinner.

Municipal purchasing is never dull. We get into every nook and corner of the ever expanding city activities. There is always something new. The Department of Parks and Recreation recently opened a new Conservatory-Aviary in West Park, and to contribute to the health and general welfare of the exotic birds housed there we went into the market for an initial supply of 400 pounds of Mexican dried flies, costing 26¢ per pound, in addition to ant eggs which we buy regularly not by the dozen but by the pound.

Pittsburgh, through its Public Health Department, was among the first to try out the new drugs for the treatment of tuberculosis and we are steadily increasing our purchases of these products. Sodium Silico Fluoride is now being purchased for introduction into our water supply for the protection of the teeth of children.

For the Public Health Laboratory we purchase beef hearts. These must be obtained just as the animal is slaughtered. They must not be refrigerated or left lying around but brought immediately to the Public Health Laboratory. The beef hearts are used to prepare a hormone agar and hormone broth for the purpose of growing pathogenic (disease producing) bacteria for all diseases, for diagnostic purposes.

We also obtain, without charge, fresh warm beef blood. This is obtained at the slaughter house early in the morning by a laboratory assistant. It is carried in a specially sterilized copper bucket with a deep thick lid that fits into the bucket tightly. The blood

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The Large Scale Production of Human Blood Derivatives

• By J. R. Fisher
ASSOCIATE DIRECTOR OF BLOOD DERIVATIVES PROGRAM, THE ARMOUR LABORATORIES, KANKAKEE, ILLINOIS

Not many people can still be unaware of gamma globulin and especially of its value in producing passive immunity against the crippling of polio. Its use during the summer of 1953 was well publicized.

Few people know how this precious drug is produced on a large scale and why only limited quantities can be made available.

This article follows the manufacturing process from the collection of human blood until the product is ready for delivery. It shows why gamma globulin is frequently in short supply when much is needed.

●

The gamma globulin and serum albumin are at present the most important components of human blood that can be separated and stored as concentrates. The gamma globulin, in a sterile 16 per cent solution is used for passive immunity against poliomyelitis, diphtheria, measles and infectious hepatitis. Serum albumin in a sterile 25 per cent solution is used extensively by the Army and Navy in the treatment of shock.

These two widely used proteins, gamma globulin and serum albumin, are obtained from blood collected by the American Red Cross. Only those persons whose case history and tests show them to be free of disease transmissible by blood products, may donate blood.

The blood is collected in pint bottles in an anti-coagulant, either tri-sodium citrate or acid-citrate dextrose (ACD). The bleeding center must use accepted standards of asepsis. The American Red Cross has blood centers in many large cities of the United States and mobile units that reach out into the smaller towns. The Red Cross designates certain centers to supply blood to Armour's new processing plant located in Kankakee, Illinois. This blood is chilled to 40° F. immediately after collection, and shipped to the processing center in insulated boxes that contain enough ice to keep the temperature at 40° F. during shipment.

The plasma is separated from the red cells by a continuous centrifugal process in a 45° F. room. These centrifuges spin the blood at 24,000 revolutions per minute. Centrifugal force separates the heavier red cells from the lighter amber colored liquid-plasma. This plasma, which contains approximately 8 per cent solids is tested for concentration of protein, sterility, and specific antibodies.

The actual fractionation of plasma into its components, fibrinogen, globulin, and albumin is a low-temperature ethanol method. This method, developed by the late Dr. Edwin Cohn of Harvard University, is based upon protein solubility. This solubility is affected by many variables all of which must be carefully controlled.

The variables protein concentration, alcohol concentration, pH, ionic strength, and temperature are carefully controlled in the Armour plant by automatic equipment. Here we start a lot with 3,200 pints of blood, which yields approximately 250 gallons of plasma. This volume of plasma is determined by the volume of our largest container (1,000 gallons). As the different proteins are precipitated, the pastes or precipitates are removed in large refrigerated centrifuges. These clarifying centrifuges hold approximately one and one-half gallons of liquid and rotate at 18,000 revolutions per minute. The paste or solids remaining in the revolving stainless steel bowls, and the supernatant or centrifugate, go into large containers.

The paste or solid material contains one or more of the several proteins or components of the blood. These are stored in stainless steel containers and, if they contain two or more proteins, must be further fractionated or separated, by being put into solution with another group of carefully controlled buffers and again precipitated.

Fibrinogen—the component that clots; thrombin—the component that causes the fibrinogen to clot; globulin—the component that contains the antibodies; and albumin—the protein that is used extensively in the treatment of shock and burns, are only a few of the components of blood.

The final paste is placed in stainless steel cans which are bomb-shaped and shell frozen in an alcohol bath at −60° F. The alcohol and water are removed by sublination, often referred to as freeze drying. This is accomplished by the use of two 14", four-stage steam ejectors, which are capable of pulling vacuum to as low as 100 microns. The usual time for this freeze drying process is 30 to 40 hours, and the powder when removed from the dryer must contain less than 5 per cent moisture.

These dry proteins, gamma globulin and serum albumin, are tested at this stage for their purity by electrophoretic analysis, sterile filtered, and placed into vials, 100 cc. vials for serum albumin and 10 cc. vials for gamma globulin. The sterile filling rooms are more inviolate than a hospital nursery. The albumin is pasteurized at 60°C. for ten hours to kill any virus that might be left in the solution.

The tests for safety, sterility, protein concentration, and potency are run on the final container. The gamma globulin is tested against polio-infected mice with careful controls, to be sure that a certain titer of antibodies is present in the final container. When it is

(Continued on Page 146)

Colloids Out of the Sea

• By Leonard Stoloff
RESEARCH DIRECTOR, SEAPLANT CHEMICAL CORPORATION, NEW BEDFORD, MASSACHUSETTS

A treasure hunt is going on in the sea for colloidal materials of value to man.

The gelling action of certain seaplants, such as Irish moss, has long been known. Now algin, agar, carrageenin, gelin and viscin grow in interest and importance. Each in its own way is valuable in controlling texture and appearance and stability in food, drug, and cosmetic products.

How do seashore farmers condition their soil with polyelectrolytes? Why is there less cellulosic fiber in seaplants than in land plants? How do seaplants obtain their nutrients?

Through the ages man's eyes have turned to the sea; first, because of what he imagined lay beyond, and more recently because of what he imagines lies in it. As the wealth of the Indies faded like a mirage to be replaced by a more substantial but less romantic wealth, so must today's dreams of food and mineral resources from the sea burst upon the hard rocks of reality, becoming as scrambled and mixed as the metaphors here employed. Since dreams have some basis in reality and it is the realities that finally emerge, let us try to separate fact from fancy.

As we view the vast expanse of ocean absorbing radiant energy from the sun, our imagination is stirred by the possibilities for photosynthesis. But the sea is poor in those elements required to complete the photosynthetic cycle resulting in plant reproduction. For these must come from the land, and they are hungrily consumed by waiting flora close to the source of supply; or they must rise from the ocean floor and depend upon upwellings or rising currents to bring the elements of reaction together. Because the seeds for growth are everywhere through the ocean and the telepathic communication of the lower vertebrates is seemingly miraculous, animal life abounds in those areas where the photosynthetic elements combine, the vegetarians growing fat and in turn being consumed until those forms result that fall prey to man. For man has been reaping an ocean harvest in a form he can assimilate in much the same way that he consumes meat rather than grass.

But man has been as wasteful of this unsown harvest as he has of all others he has not worked to plant. When he applies to this bounty of "edible" food the efficient and perpetuating harvesting procedures of which he is capable, he will have achieved his dream of plentiful food from the sea.

And what of the minerals that are constantly being washed into the vast reservoir of the oceans? Their very vastness makes the oceans a more suitable place in which to lose those things that are unwanted than a source of those elements that are desired. Of this every sea-coast community is well aware. The most abundant mineral in the ocean, sodium chloride, is obtained more easily and in a purer state from deposits in the earth. For a while, potash, and later, iodine, were recovered by burning those seaplants that concentrated these elements from the sea in their bodies. But much as location of the mother lode changed the emphasis from the pan to the pick, so did the location of saltpeter and iodate deposits smother the fires of the kelp kilns. Then, as the exception to prove the rule, or more probably that each case must be judged on its own merits at the time and place, the production of magnesium from sea water has recently won out against its production from mineral deposits, carrying bromine production along on its coat tails.

As always, the answers to dreams lie where least expected. Virgil could imagine a no more degrading remark than "vilior Alga." Now, these seaweeds are an important raw material for modern industry. Last year over twenty million pounds of seaplants were processed in the United States to yield finished products with an estimated value of over seven million dollars.

And this is not a picture restricted to the United States alone. What did Virgil overlook? Only what is familiar to all shore dwellers: that plants of the sea are rich in materials that hold onto water tenaciously, or having lost water, regain that loss rapidly on aqueous immersion.

For centuries, seaplants valued for their gelling properties have been articles of commerce of oriental sea coast communities. The Javanese name, agar-agar, which applied to the whole plants, has since been adopted by the Japanese who used it to designate the active principle they learned to extract and purify. Japanese preeminence in production has made the town names of Kobe and Yokohama most widely associated with the product. In recent years, what was once a virtual Japanese monopoly is meeting competition from the United States, Mexico, Chile, New Zealand, Australia, Portugal and Spain.

On the rocky eastern shores of the North Atlantic basin, the moss-like growths exposed to view by the receding tides or thrown up on the beaches by the waves to bleach in the sun, were known to be rich in a substance that would set milk into puddings, soothe chapped hands or sore throat, relieve the croup, and counteract any one of a dozen disabilities. It is impossible to tell how many generations of grandmothers were acquainted with the virtues of the "moss," although vague hints indicate it may have been known to Hippocrates, possibly through the travels of the Phoenicians. The name Irish moss, the designation it carries today, is due to the chance that the first published accounts of its medicinal value described material obtained from Ireland. Synonymous

Irish designations are carrageen or carrageen moss, so that when a name was required for the active principle it became carrageenin.

Descendants of the French and Irish grandmothers, migrating westward across the Atlantic, early recognized the same plant as growing abundantly along the New England and Canadian maritime shores.

Their efforts to gather moss and compete with the European imports developed the know-how and formed the nucleus of a system which helps supply a United States industry producing refined carrageenin on a scale not conceived of ten years ago.

After kelp burning became uneconomical it seemed that Virgil was correct, particularly in regard to those huge, leather-like, brown growths that form such a conspicuous part of the marine flora. Then a valuable principle locked inside the plants was revealed through the inquisitiveness of the English chemist Stanford. Called algin by him, it remained a laboratory curiosity through half a century. After several abortive attempts by companies in France and America to prepare and market algin had laid the groundwork for the know-how of production and application, a vigorous infant emerged from the struggle. It located on the Pacific coast where grows the most prolific and accessible raw material for the production of algin, the giant kelp, *Macrocystis pyrifera*. Nurtured on this firm base, America's algin industry has grown solidly and steadily until today it is the world's largest producer of seaplant products. Trying hard to overtake this healthy youngster are producers in Norway, England, Spain, Chile, and Japan.

So we find as today's treasures of the Indies, agar, algin, and carrageenin. Their value lies in the seemingly miraculous way in which, under man's guidance, they tame water, making it do things for which water never seemed intended. The fluidity can be controlled through all gradations to immobility in either a paste or gel form. Particles that would ordinarily sink in water are kept suspended. Oil that would ordinarily rise is kept dispersed. The hard solid that should form on freezing becomes a mush of crystals.

All this is not new. The pharmacist has always used water-soluble gums or mucilages to accomplish these same results. Karaya, tragacanth, and acacia have long been a part of his lexicon and stock. Jelly making is an old household art. Flour and starch have always stood the baker in good stead.

What is new is that a growing industrial, food, drug and cosmetic technology has been striving to provide a more and more critical consumer with a greater variety of stable, convenient products; and the man-made colloidal state has become an increasingly important part of our attempts to outdo nature. For this, large quantities of uniform, dependable and versatile agents have been required to obtain and control texture, appearance, and stability. The seaplants, provided in abundance by nature, and rich in the necessary hydrocolloids, have filled this need.

The seaplants, unlike the plants of the land, are not equipped with a vascular system through which the most remote parts are fed from a moist substrate. Instead each cell must absorb its own nutrient from the medium in which it is bathed. And even more than the supple willow must yield before the wind to remain attached, so must the plants of the sea stream with the ebb and flow of the currents and yield before the pounding waves. Thus we find in the cellular make-up of the seaplants a minimum of the cellulosic fibers that lend structural rigidity, and more of those carbohydrate polymers similar to the pectinous materials in the soft pulp of ripening fruit that provide toughness, flexibility, and great water-retaining capacity.

Because the exchange of metabolites between the cell and the sea takes place through the cell walls, it is not surprising that a mechanism exists for selective absorption of the desired elements from among those found in the brine. In his creation of ion-exchange compounds man is only mimicking these polyelectrolytes that have controlled the base exchange metabolism of seaplants for untold eons. Farmers along the shore, spreading "kelp" on their fields, have been using these same polyelectrolytes to improve soil and crop, unknowingly presaging the day of the polyelectrolyte soil conditioner.

Despite the confusion of shape and form that seems to exist among the plants of the sea there is a certain orderliness and thread of interrelation that can be found. This is first seen in the pigmentation. In addition to the omnipresent chlorophyll, there are four separate pigments, each distinguishing a clear-cut family. Two of these dominate the coastal vegetation. The generally larger forms, the *Phaeophyceae*, are unmistakably brown, while the *Rhodophyceae* will display their red pigment unless starved for nitrogen when they show green or a mottled red and green. Even more deep seated similarities are revealed by the commercially stimulated research into the nature and distribution of seaplant hydrocolloids.

Algin, or a polyuronide of the sugar mannose sufficiently similar in properties to algin to warrant that designation, has been found in all brown seaplants so far investigated. Differing only quantitatively and not qualitatively in their reactions, these polyuronides form water-soluble salts of sodium, potassium, and ammonium that impart viscosity and have all the essential attributes of the water-soluble gums.

The polymannuronic acid itself as well as its calcium and magnesium salts are not soluble, but, sponge-like, do absorb a tremendous quantity of water so that when precipitated from a solution of a soluble salt under the proper conditions a gel structure can be formed. The insoluble chromium, beryllium, and cadmium salts of algin are not water-swelling so that when prepared by extrusion of a soluble alginate solution into a precipitating bath, fibers are formed, which, because of their high inorganic content, are useful for the manufacture of flame-proof fabrics.

The common thread of hydrocolloid structure that runs through the red seaplants is the presence of the six-carbon sugar galactose combined with sulfur in the sulfate ester form. The amount of sulfate ester in these galactans is a variable, distinctive of certain seaplant types that may signify close biological similarity. Another distinctive variable is the physical properties of each hydrocolloid in water solution.

(Continued on Page 145)

The Transistor

• By R. D. Lohman
RADIO CORPORATION OF AMERICA, RCA LABORATORIES DIVISION, PRINCETON, NEW JERSEY

Introduction

In the past five years the transistor has made the remarkable transition from a laboratory curiosity to a device capable of challenging the well entrenched king of electronics, the vacuum tube. Although a comparative newcomer itself, the transistor is in fact descendent from one of radio's earliest basic components. The crystal, or "cat-whisker" detector was one of the first devices ever used to demodulate radio frequency waves and extract their intelligence. With the advent of the vacuum triode, the crystal set became a rapidly vanishing member of the radio family although crystal diodes have remained in general use. Even today, in certain applications such as microwave detectors, they outperform the vacuum type.

Basically, the phenomenon which makes crystal and vacuum diodes useful is their ability to rectify electrical signals. This, in turn, means that they permit current to flow through them more easily in one direction than the other.

If, between the plate and cathode of a vacuum diode we insert a third electrode consisting of a fine mesh of conducting wires, we have the makings of a basic vacuum triode. When the plate-cathode diode is biased in the forward or easy current flow direction, (i.e., when the plate is made positive with respect to the cathode) and the wire mesh, or grid, is made negative with respect to the cathode, we find that the current flow from plate to cathode may be carefully controlled by varying the voltage between grid and cathode. Normally, the grid voltage is not varied to such an extent that it becomes positive with respect to the cathode. The grid current is therefore essentially zero and the power dissipation in the grid circuit negligible. The tremendous usefulness of the triode arises because it makes possible the control of relatively large amounts of energy with an expenditure of practically no energy. Before proceeding to the possibility of obtaining a similar effect with a "crystal triode," let us consider some of the elementary properties of semiconductors in general.

THE TRANSISTOR . . . WHAT IT IS . . . WHAT IT DOES

The tiny transistor—a laboratory curiosity only five years ago—is today being "proved out" as a versatile, precise and often economical valve for controlling electrons in the circuits of electronic equipment for national defense, industry and the home.

So important is the promise of the transistor that the Radio Corporation of America, pioneer in radio, television and electronics, is directing a large portion of its technical resources towards bringing this diminutive device into greatest usefulness.

In its present form, the transistor consists of a small crystal of the metal germanium imbedded in a plastic shell about the size of a kernel of corn.

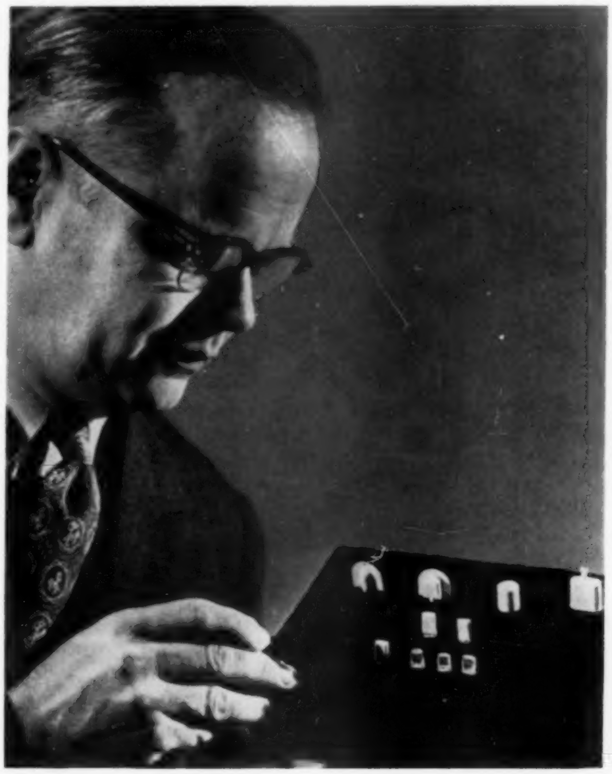
Broadly, WHAT the transistor can do in, say, a radio set is similar to the work done by many types of electron tubes. But there is a difference between tubes and transistors in HOW these tasks are done. The electron tube controls electrons in a vacuum. The transistor controls electrons in a solid—a carefully prepared germanium crystal.

For use in a transistor, germanium, one of the basic elements once considered rare and relatively useless, must be purified until there is no more than one foreign atom to each 100,000,000 germanium atoms. It must then be painstakingly crystallized and sliced into tiny pellets or wafers.

The transistor's ability to command electron flow within a speck of solid matter gives it some remarkable potentialities—not only for simplifying present-day apparatus, but for inspiring the design of devices heretofore impossible, even unconceived. As the problems of producing transistors by the million are overcome, the transistor will find its place as a companion of the electron tube.

Crystal materials are designated as insulators, semiconductors, or conductors according to the ease with which they carry electric current. The ratio of the current density in a material to the electric field strength necessary to maintain that current density is called the conductivity of the material. A perfect conductor would have infinite conductivity, a perfect insulator zero. Somewhere in between there is a class of materials whose conductivity is of such a value that they are neither good conductors nor good insulators, and these are designated as semiconductors. It should be pointed out that the dividing line between conductor, semiconductor, and insulator is not always sharply defined. In fact, some materials run the gamut from insulator to conductor as their temperature is raised.

The conductivity of a material depends on the number of charged particles it contains which are free to move. The particles may be free electrons, free holes, or both. The term "hole" has been given to what may more accurately be called an electron deficiency. A hole exists where there is an electron missing from a site in the crystal which normally holds an electron. As a neighboring electron fills the hole, it leaves a vacancy behind and thus the hole effectively moves



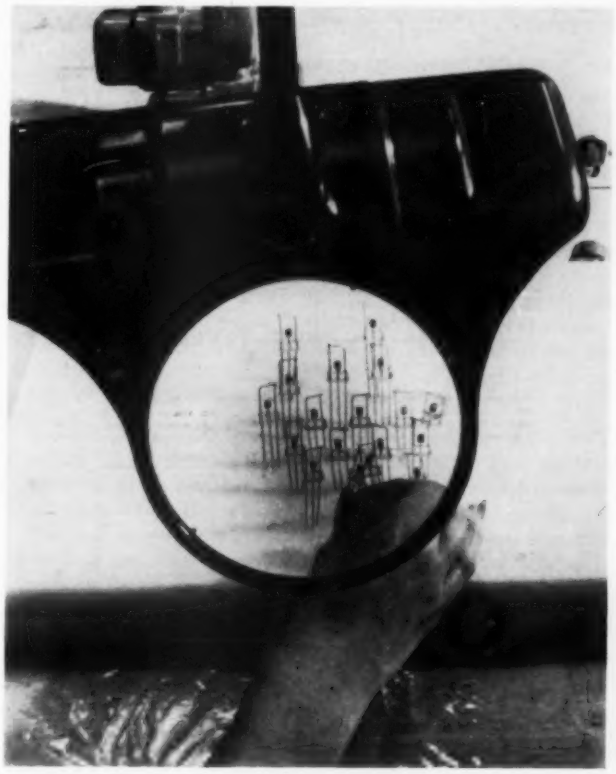
NEW TYPES OF TRANSISTORS DISPLAYED — Dr. E. W. Engstrom, Vice President in Charge of RCA Laboratories Division, examines ten types of transistors employed in demonstrations of the extensive potential application of these tiny devices, built around specks of germanium crystal, which perform many of the functions of electron tubes. The four transistors in the front row are developmental types, a junction transistor at the left, the other three point-contact varieties. The middle and rear rows are made up of experimental junction transistor types. The larger transistors are for handling higher power in electronic circuits.

and contributes to current flow. Semiconductors which are absolutely pure have equal numbers of free electrons and holes and are called intrinsic semiconductors. Very pure germanium exhibits some intrinsic conductivity at room temperature. By introducing minute quantities of certain impurities into the germanium, it is possible to increase the conductivity by establishing a large majority of either free electrons or free holes. If the number of electrons exceeds the number of holes, the germanium is called n-type; if the converse is true, it is called p-type. Transistors are made from both n- and p-type germanium and junction transistors depend for their operation on phenomena which occur when a single crystal of germanium undergoes a transition from one conductivity type to the other.

Point Contact Type Transistors

An n-type point contact transistor is made by placing two sharp phosphor-bronze wires closely together on a block of n-type germanium. A soldered connection is also made to the block, or base as it is called, thus providing three accessible terminals. Externally then, the transistor resembles two point contact diodes using a common crystal. If one of the points, called the collector, is biased in the reverse direction (negative with respect to the base for n-type germanium) and the other, called the emitter, biased in the forward direction (positive with respect to the base for n-type germanium), it is found that the current which flows in the collector circuit is controlled by the current which flows in the emitter circuit. One of the most important parameters in such a transistor is the ratio of the change in collector current produced by a unit change in emitter current. This quantity, called the current gain of the transistor and denoted by the symbol α, is usually between 2 and 3 for point contact transistors. That is, for each milliampere change in emitter current, the collector current changes 2 or 3 milliamperes. Since the emitter current flows through the low resistance forward biased point, while the resulting collector current flows through the high resistance reverse biased point, greater power gain is obtainable than that which results from the current gain alone.

Point contact transistors have found use in a variety of applications. Like all transistors, they require no heater or filament current and operate instantaneously when energized. They are tiny—after encapsulation about the size of a piece of candied chewing gum—and are thus well suited to circuits where space limitations are a factor. As amplifiers, they are capable of power gains in the order of 20 db. per stage and pro-

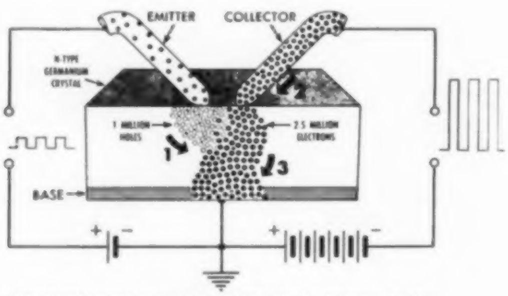


RCA POINT-CONTACT type transistors, complete except for plastic coating, look small even when viewed through a magnifying lens. These transistors which perform some of the functions of electron tubes are being produced at RCA Victor's Harrison, N. J., plant. The plastic coatings hold the minute transistor assemblies in place and protect them against shock, vibration and moisture. A finished transistor, shown at the extreme right, is hardly larger than a kernel of corn.

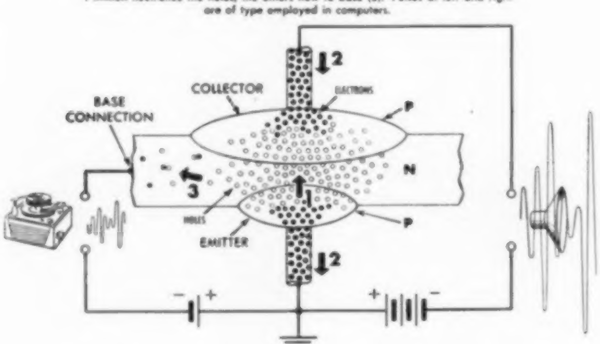
vide power outputs of from 50 to 100 milliwatts. Because of their inherent instability, point contact transistors can be made to oscillate readily in either a sinusoidal or relaxation mode, and frequencies as high as 300 million cycles per second have been obtained. Perhaps they are most adaptable to switching and computer applications and it is in these fields that they have found their first commercial importance.

Junction Transistors

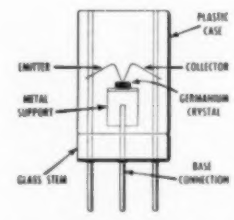
If the conductivity along a single crystal of germanium is caused to undergo a transition from one type to the other, there is formed at the transition point a so-called p-n junction. This junction possesses excellent rectifying characteristics and the crystal can be used as a rectifier if soldered contacts are made to the ends. If two transitions are made, that is either n-p-n or p-n-p, the crystal becomes a junction transistor. Let us consider such a transistor of the p-n-p type. In this case, the first p-section functions as the emitter, the thin central n-section as the base, and the second p-section as the collector. As with the point contact transistor, the collector is biased in the reverse direction and the emitter in the forward direction. When thus energized, the emitter junction emits holes into the n-type base region which diffuse across and are collected by the collector junction. The current gain of a junction transistor is usually very nearly equal to, but always less than, unity. As a typical example, a change of 1 milliampere in emitter current produces a change of .95 milliampere in collector



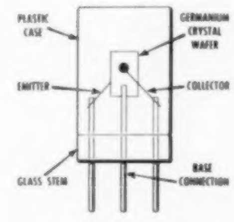
Enlarged point-contact transistor: If a signal injects 1 million holes at emitter, they will be attracted towards collector (1). Near collector, holes reduce barrier to electron flow (2) allowing some 2.5 million electrons to pass into crystal. Of these, 1 million neutralize the holes; the others flow to base (3). Pulses at left and right are of type employed in computers.



Enlarged junction transistor: Small signal from phonograph is amplified to activate loudspeaker. If the signal changes by 1 million electrons, for example, there will be a voltage difference between emitter and base which starts 50 million holes flowing out of emitter (1). All but 1 million holes get to collector, inducing 49 million electrons to flow and carry current in collector circuit (2). The remaining holes flow to the base completing base-emitter circuit (3).



Elements of point-contact type transistor



Elements of junction transistor

DRAWING SHOWING elements of point-contact type and junction type transistors.

current and 0.05 milliampere in base current. This characteristic of junction transistors is of primary importance because it renders them short circuit stable and therefore permits a great flexibility in circuit arrangement. Also, since the base current is only a small percentage of the emitter or collector current, it is advantageous to use the base current to control the transistor.

One of the most startling features of junction transistors is their ability to operate at extremely low power levels. Satisfactory performance can be obtained at input powers of only a few microwatts. As an illustration, a junction transistor audio oscillator has been built which derives its operating power from the light energy in a room of average illumination.

As amplifiers, junction transistors are capable of power gains of 40 to 50 db. per stage and, limited by heat dissipation problems at the present time, of power outputs of about 500 milliwatts. The frequency response is relatively poor; most units operate satisfactorily only in the range below 1 million cycles per second. However, it seems certain that this limitation will be extended considerably in the next few years.

It is natural that the performance of transistors be compared with that of vacuum tubes. Such comparisons are often useful as an orientation procedure for persons who are already familiar with vacuum tube circuits and are endeavoring to become so with transistor circuits. However, it should be emphasized that the optimum utilization of transistors requires more than a simple substitution in conventional vacuum tube circuits. The similarities between the two devices are perhaps more obvious than their dissimilarities. However, it is the author's opinion that it will be the exploitation of those characteristics found only in transistors which, in the long run, will prove most beneficial in extending their usefulness to the electronics art. ●

★ ★ ★ ★ ★

How many examples have we had of ideas, abandoned as worthless and thought to be quite discredited, which nevertheless came to life again? What ideas were more certainly dead in the second half of the nineteenth century than those of the transmutation of the elements and the corpuscular theory of light, and what more certainly alive today?

—HERBERT DINGLE
The Scientific Adventure

Science and Society

• By W. A. Gruse, Ph.D., (University of Wisconsin)
GULF RESEARCH & DEVELOPMENT COMPANY'S MULTIPLE FELLOWSHIP, MELLON INSTITUTE, PITTSBURGH, PENNSYLVANIA

Throughout the centuries society has progressed amazingly in a material way. The spiritual advance has not been so marked. How has the development of science influenced the situation?

This thoughtful article points out a number of ways in which scientific research has affected our manner of life. Careful planning and controlled, cooperative effort account for much of our material success.

Dr. Gruse uses a discussion of foods and medicines to illustrate his views.

You will think about much of what he says as you go about your daily work.

•

Human civilization, if we look at it the right way, is a great spectacle of man's effort to control his environment in such manner as to supply his needs.

The earliest way of life we know much about is presumably that of Aurignacian man, who lived in limestone caves in southern France and northern Spain about 25,000 B.C. From his kitchen hearths and midden heaps—the refuse piles—and from his art—the cave paintings—we know that his needs were not only material, they were also spiritual. We can picture human civilization as a progress, with set-backs and relapses, but we may as well confess that we do not have much to boast about in satisfying our needs for a better spiritual life.

The primitive religions apparently contained much that was brutal and brutish, and were compounded of gross superstition. Even the early Hebrew religion as pictured in the Pentateuch could stand some improvement; and I understand that the story of its improvement is the theme of the Old Testament. During the twenty-odd thousand years since the cave dwellers of the Dordogne valley painted their walls with charcoal and yellow ochre, man's religions have undergone a purification. It has not been too steady, but it has moved on, and we can perhaps hope for still more improvement, particularly in man's *attitude* towards his religion. But we must remember that inspired priests and prophets have brought us these improvements. We have little to be proud of in the way of our own achievements in the field of ethics and religion.

We have done a little better on the material side. Man's physical needs in the order of occurrence are food, shelter, weapons, clothing and medicine. Most of us have a fair idea of how primitive man met the demands of his body for these essentials for staying alive. The human race has seen its idea of an acceptable meal develop from a diet of grubs, shell-fish and nuts to green turtle soup, filet mignon and crepes suzette; shelter has improved from a hillside cave to a modern apartment or a ranch house; weapons from handily shaped stones to bazookas and proximity fuzes, to say nothing of atomic bombs; clothing, after the era of dressed deerskins, has grown from marvel to marvel; medicine is still miraculous.

These changes and advances have not just happened; they have been brought about by man's ceaseless efforts to do better by himself. We need not assume that all the great things mankind has achieved have been inspired by lofty motives. Probably many of them, as someone has pointed out, were results of the efforts of lazy men to save trouble. Certainly rolling a stone on sections of a tree trunk is easier than carrying the stone; from that device to a wheeled cart for the stone is just a step. But it is trouble to build the cart. So we have an anomaly; lazy men go to extra trouble. The explanation is that progress is made by men willing to exert themselves now so that they may be lazy later on.

This act of forethought is perhaps the key to much of the material success of the modern world. In contrast to the hand-to-mouth exertions of primitive man, our effort today is a considered effort. By this I mean that, leaving out war and other natural stupidities, the work of the modern world is cooperative and it is very largely planned for best results, rather than taken just as it bobs up. This planning is most obvious in an assembly-line production of, say, automobiles. The assembly line can be pictured as the main stream of a river system, with tributaries along its entire length. These tributaries carry shaped steel pieces, wood and glass, bolts and nuts, carburetors and spark plugs at carefully timed rates to the main line so that complete automobiles may be assembled at a steady pace and roll off regularly at the delivery end.

This basic philosophy of planning and controlled effort has been outstandingly successful in a material way. But it has already shown that in certain things of the mind and of the spirit it can be deadly, too. I have grave doubt that the philosophy of planning can be trusted to work out a good way of life which can be imposed from above by the few upon the many. Even if we assume that there will live with us, now or in the foreseeable future, men of super-intelligence, capable of planning political and social progress for our complex civilization, even so I doubt whether we would be willing to entrust the lives of the nation's children to such planners. Not only would such a system call for god-like intelligence, but it would call still more for god-like virtue and goodness. Both seem rather scarce on earth just now.

And yet the unfortunate way in which the world's affairs have been going recently indicates strongly that

we need something or other a little better than we have had. Planning sounds fine, and with a rising world population, a shrinking planet and a food supply diminishing in a relative sense, it seems inevitable that we shall be victims of some nation-wide planning pretty soon, whether or not the supply of virtue and intelligence are adequate. We have seen what planning has done in Russia, to the governed and to the governors. We have seen it to a much lesser extent in England, and I think we agree that we don't care for any just now. And yet I suspect and fear that unless some new element makes itself felt, our grandchildren may be living in an economy planned from above.

I decline to view this prospect with the alarm which might seem justified. Even aside from my inability to prophesy, I feel that there *is* a new element which will make itself more and more felt as time goes on. I refer to the influence of scientific research on our manner of life. I say scientific research, to distinguish it from the fact-finding activities of advertising agencies, public opinion bureaus and what not. You may have heard of the proposed distinction, by which the latter is called re-search, while the real quest for new knowledge is properly designated research.

I believe that scientific research can make so profound a difference in what we may expect, because it is so utterly unpredictable in its directions and its consequences. And the essence of our worry about the world's dismal prospects is that those prospects are predictable. When an unpredictable element has been added to a situation, worry becomes unnecessary.

I have mentioned research as the new element in the technical and material side of our civilization; that is because in our organized society it is the chief means by which practical advances are made. Actually, of course, mankind has been making practical advances ever since the day when the phenomenon called civilization got its start. Progress was slower, but it was just as unpredictable and just as irregular. Nobody could tell when a civilization would suddenly burst into flower in Greece or in Tuscany, or when some solitary genius like Chauncey Jerome would revolutionize the clock industry of his native Connecticut.

But the bursting into flower has always been easier for a crowd than for one or two. Things began by a discovery here or there; someone learned how to make a fire-place, and five thousand years later someone else made the first wheel. And maybe the pace quickened and the lever followed pretty soon, and maybe things burst into bloom when the discovery of wine and leavened bread and how to have roast pig without burning the house down all came in a breathless rush of five hundred years.

But appetite comes with eating and one discovery leads to another. It has been a saying among those who philosophize about discoveries, that often the mere pressure of accumulated information leads to revolutionary inventions. You have read about the atomic bomb, that explosion does not take place until the amount of fissionable stuff in a given space increases beyond a critical amount; then things happen. The accretion of knowledge seems to act in much the same way.

Even as late as the days of Benjamin Franklin, a few learned men, scattered here and there, one or two in Austria, a dozen in France, a dozen in England maintained a sporadic correspondence about their scientific observations and their ideas. It was more or less like the process of lighting a torch from another one held by a man across the street and then passing on your fire to the man at the next corner. In those days and until recently, there was no spontaneous expansion and nothing explosive.

Contrast that with what happens nowadays, when the number of scientists, engineers and learned men has increased beyond anything Isaac Newton or Franklin would have dreamed possible. There are perhaps half a million persons in the United States alone who are professionally devoted on a pretty high level of education and achievement, to science or engineering. Now these people are not zealots or wild-eyed fanatics. They are most probably mild mannered and inoffensive, with a taste for baseball and bridge and maybe a little beer now and then. Yet all these people tacitly assume, in fact they would refuse to discuss any possibility of not believing, that science and engineering will change and develop rapidly and restlessly, and that the condition will prevail as long as our present way of life persists. To them and to most of us, science means not just knowing about nature, but knowing the laws of nature and using the knowledge for beneficial changes. If you point out to them that this may mean constant change of everything in our civilization, they will say "naturally; why mention it?"

The point, of course, is that a fair proportion of these half-million people are devoting their lives to the finding of new facts; each discovery calls for a dozen more and we have an expansion of scientific information somewhat like the expansion of the universe which the astronomers tell us has been going on since the critical half-hour several billion years ago.

Now I had intended to talk to you about the purely material implications of purely natural-science studies, of purely physical problems, but I have been carried away by the philosophical implications of these interesting topics. And it is difficult to find something purely physical in our world today which does not have philosophical overtones. Let us take food—metaphorically. We all take it literally several times a day; most of us like it. Food and its consumption are certainly earthy and physical enough to suit anyone. But let us consider just a bit further.

The nutritionists and the medical men agree that many diseases and even some mental conditions can be attributed to food deficiencies; so food affects deeply the destiny of the individual. The learned people agree that plenty of lime in the drinking water and plenty of high quality protein food such as eggs and liver and red meat produce tribes of tall, handsome, and dominating people—what the Odyssey calls children of kings; so food affects deeply the destiny of peoples.

And finally we know that wars are fought about food supplies, that Tibet and Arabia and Central

Australia can support only a sparse population, and that the gravest questions about the future of humanity on earth are tied up with the question of how much food we can produce as a steady thing for the next few thousand years. So food affects to a very great extent the destiny of humanity as a whole. So let us talk about food for a bit.

The food problem is different, depending on the viewpoint. In this country there is plenty, and our problems are in regulating the amounts and choosing those foods which will keep us in best health. For most of mankind, there is not enough and often it is not of the right kind. Great areas in the densely populated East live constantly under the shadow of starvation. We have therefore two basic problems, first how to produce more food and second what are the best foods. So it will be interesting to know what scientific research is doing about these.

We know that food production has increased very largely in this and in most civilized countries in recent years. Not only so, but the crops are now raised with less expenditure of man-hours of labor, partly of course because of power-driven implements, but partly because of better crop plants. The fact that some of this more plentiful food has been dumped or plowed under is not the fault of the scientists. The increase of food production has been due to improvement in seed, fertilizer, and insecticides. What the plant breeders have done with hybrid maize corn is pretty well known and they are at work on other food crops. They have been changing the structure of food plants, cutting down needless stalk length, improving the size and shape of ear, and so on. Iowa is now conscious that tall corn may be a sign of bad farm management. I am sure that the plant geneticists and the agronomists feel they have just made a start on a long and happy career of thumbing their noses at Malthus.

Organic soil fertilizers are as old as Abraham; human and animal wastes are returned to the soil to keep up its productiveness. Such customs keep up its disease-spreading capability also, and in some countries, even in this hemisphere, one dare not eat uncooked vegetables. But inorganic fertilizers, except lime, are matters of about a hundred years. We all know about adding potash and phosphates and nitrates to our soil to replace what the crops take out. This has worked pretty well, but we have found that gradually the soil has lost its fertility in spite of this lime and potash and what not. Recently we have recognized that the soil needs also to be kept up as to trace elements, copper, boron and manganese, which the plants need, in traces only but most urgently. The effect of adding these and the half dozen others in this class is often dramatic.

The insecticide story is a long one in itself. The newspaper readers have heard about DDT and gammexene and a lot of other insect poisons, and they have seen pictures of dusting these from airplanes; and we recall the first plentiful potato over-production of a few years ago, brought on because the growers had underestimated the potency of DDT. That potato prices have not dropped is again not the fault of the scientists. The insecticide business still presents a long series of problems, but like the agronomists, I suspect that the insecticide people feel they are on the way to solve all mankind's food difficulties. No doubt we shall have better-yielding, more disease-resistant food crops, better-balanced fertilizers and more potent, more all-effective insecticides. It is possible that before long, insect-killing chemicals can be fed to plants, so that the insect may find the plant distasteful or poisonous, even though the fruit is not spoiled for man. We may even have foods made from rapid-growing algae and yeasts, or food sugars synthesized in nutrient solutions by the agency of sunlight.

The animal breeder has been doing to food animals what the plant breeder has done to plants, bigger bodies, more milk, more eggs, better resistance to disease, all on less food. And recently has come the striking effect of antibiotics, penicillin and so on, put into the food of animals. Apparently, by killing off the bacteria in an animal's digestive tract, the animals use their food more efficiently, and grow more quickly to greater size on less food. This does not work for beef-cattle and other cud-chewers, because the bacteria in a cow's several stomachs are beneficial—they help to digest the grass and hay the cow eats. To be exact, they hydrolyse the cellulose into digestible sugars. But apparently for pigs and poultry, a good part of the intestinal flora are harmful and had best be killed off. So again there is a good possibility of increasing the food supply.

This business of intestinal flora is not new. We have known about the *lactobacillus acidophilus* and Bulgarian buttermilk and yoghurt. Just why the process should stop at this point is not clear. One can imagine setting up in one's intestinal tract cultures of benevolent organisms which might control food assimilation, growth and health in most unexpected and interesting ways.

One item related to the food situation, but not so obviously, I would like to mention. Chemical manufacturing has produced from inorganic sources, particularly coal or petroleum, materials formerly derived from food products, or from the soil. Forty years ago, the Germans commercialized the synthesis of indigo from coal tar chemicals, thus releasing crop land for food growth. More recently, American chemists have produced large quantities of industrial alcohol from petroleum gases, thus releasing grain and other sugars and starches for food purposes.

We can take another minute or so to discuss another field of achievement and adventure. Medicine is probably one of the two or three areas in which the advance due to applications of science has been most striking. To a layman like myself, the two developments most responsible have been, first, the concept of asepsis and the discovery of aseptic techniques for surgery and for research; second the application of chemical synthesis to the job of making new drugs for particular purposes, the sub-science of chemotherapy. If to these two basic approaches there are added all the resources of science and engineering—and we can be sure that will be done, since mankind is keenly interested in staying alive—the sky at once becomes the limit. The use of frozen and

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A Non-Academic High School Physics Course

• By Brother Gabriel, F.S.C.
DEPARTMENT OF PHYSICS, CENTRAL CATHOLIC HIGH SCHOOL, PITTSBURGH, PENNSYLVANIA

An account of how one high school takes care of senior science students whose lack of proficiency in mathematics precludes their entrance to the standard physics course.

You will note the reaction of students and parents to the new non-academic course. You will be interested, too, in the method of grading and its justification.

Other schools may care to follow the plan outlined.

Three years ago a program was arranged at Central District High School in Pittsburgh to cope with the problem of mathematics-deficient senior science students. We like to think of it as an applied physics course, but in reality it is "a non-academic physics course."

At the close of each junior year, the mathematics and science teachers arrange their pupils into two categories: those who showed marked ability in chemistry and algebra, and those who did not. The former group is placed in those senior science classes that include both trigonometry and physics in their curriculum. Incidentally, one senior class is reserved for boys whose talents are rather extensive and who have no aversion to hard work. Usually these boys are college bound. Most of the college scholarships are won by members of this class.

The science students are graded on the basis of their third-year achievement. Their general averages influence this grading to a great extent. This makes for homogeneous classes. The placement of these boys is made by the school officials. The junior teachers, once their opinions, recommendations and grades are turned in, have no further say in the senior class arrangement.

Since the seniors are briefed on what their status will be, come September of their senior year, the physics teachers arrange their material to suit the levels of their various classes. For the most part, and I know of no exception, the four or five classes, representing as they do the phys-math section, get exactly the same lectures and demonstrations. So well in fact are they paced, that departmental quizzes and quarterly tests are the order of the day.

Every year, however, we have some forty or fifty boys who are found wanting in the fundamentals of arithmetic and algebra. To subject these boys to the intricacies of the mathematics portion of physics would be a waste of time. They literally cringe at the sight of a word problem or decimalized number.

For these, then, we set up our applied physics course. We eliminated the mathematics from the course and concentrated on theory and laws. When the matter lent itself, we delved into lengthy explanations, supplemented with diagrams, still pictures, lecture demonstrations and movies to show the practical aspects of the laws. We used any and every kind of visual aid to bring the matter home to them. The electrical field is particularly appealing to them; so much so, that after a few weeks of lessons, they often pose as experts among their friends and offer their services to install and repair electrical fixtures.

In the laboratory we followed the experiments exactly as assigned to the upper echelon. The boys really enjoyed the laboratory work, and it must be said in passing they seemed to attack the mathematics end of the experiments quite fearlessly; a number quite successfully. This delighted them; the teachers also.

At rather frequent intervals tests, taken from workbooks, were given on theory, laws and diagrams. These tests were tailored to suit the matter stressed in class and laboratory.

Quarterly tests were given at the scheduled times. The test was usually based on 40 points. Added to this were points from the laboratory work, quizzes and homework. When all the points were totalled they added up to 100. When all the marks were completed, those from 92 to 100 were given "74"; 85 to 91 a "73"; 78 to 85 a "72"; 71 to 77 a "71"; 70 received "70."

Scalings of this sort are in order for the following reasons: First: It is easier to score high in this applied course and therefore unfair to compare these marks with those of the academic physics students. Second: If these high scores were used in computing the general averages at the year's end, then these boys would generally hold loftier spots in the graduation class standings than their accomplishments deserved. Third: The certifying grade for college set by Central is 75. Since these students could not be recommended for college, it was decided to limit them to 74. Some, however, take and pass college entrance examinations and make out surprisingly well.

Now a word or two on the student-parent reaction. At first, the parents of some of the students were disappointed and expressed themselves that their sons were relegated to a class that looked, on the surface, like a conglomeration of oddities. However, with a little explanation they began to see the teacher's side and the wisdom of this arrangement. Those who at first refused to see things our way, did so when they were shown the results of the math-screening test that their sons took. For the most part, the deficient students were delighted with the opportunity presented to them to ease out of a situation that could set them back on their academic heels. Naturally, some of the students frowned fiercely when they were informed of their status, even when the WHY was explained, but once under way their disappointment vanished. The teacher made a special effort once the matter was

(Continued on Page 142)

The Family of Brasses

• By Carl H. Pihl
COPPER AND BRASS RESEARCH ASSOCIATION, NEW YORK CITY

This article tells the story of the brasses, the most useful of all copper base alloys.

When copper is alloyed with from five to forty per cent of zinc, brasses of a wide range of beauty and usefulness are obtained. Their colors range from red gold through typical bronze to bright yellow. They find uses as varied as the manufacture of ships' propellers, and watch parts, costume jewelry and architectural trim.

The brasses have an interesting history.

The origin of Brass—as an alloy and as a word—is a mystery. Neither the ancient Greek nor Roman language makes any clear distinction between copper and brass, and most authorities now agree that the numerous Biblical and Homeric references to "brass," in English versions, are probably errors of translation. The metal referred to was undoubtedly copper or bronze, an alloy of copper and tin. The derivation of the English word "brass" is unknown; in Elizabethan times brass (the alloy) was known as "latten," a word similar to the French *laiton*.

Archeological discoveries have established that man used copper and bronze long before the dawn of recorded history. It is generally believed that The Bronze Age began sometime between 8000 and 7000 B. C. Relics found in Egypt definitely establish that copper was used there in 5000 B. C. and that bronze was used in 3700 B. C.

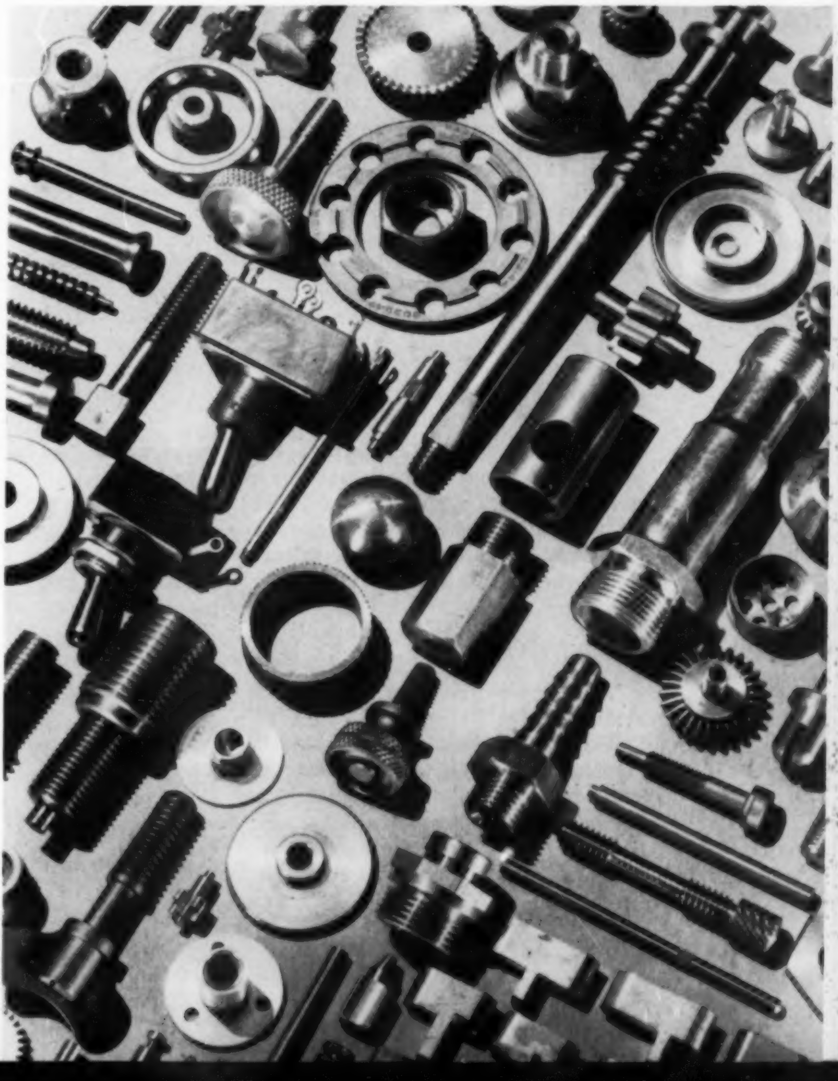
The earliest known example of brass is a Roman coin made during the reign of Augustus (27 B.C.—14 A. D.) which contains approximately 17 percent zinc. This alloy was not produced as brass is today, but was a mixture of copper and calamine, a zinc silicate ore. Brass was made in this manner until 1781 when the modern process of making brass by the direct fusion of copper and zinc was developed by James Emerson in England.

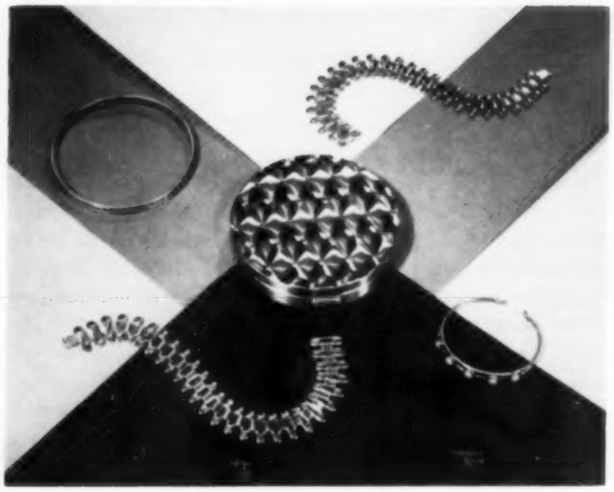
Modern brass makers owe a great deal to the endless experiments of the alchemists of the Middle Ages, who sought by the transmutation of metals to produce gold and silver from less precious metals. The tireless research and study of men like Agricola, Paracelsus and Swedenborg resulted in the accumulation of much data concerning the alloying of copper, zinc, lead and tin. This led to the introduction, during the 18th and 19th Centuries, of literally hundreds of different copper-base alloys, most of them brasses. Some of these alloys were known by such picturesque names as Mannheim Gold, Pinchbeck, French Oreide, Mosaic Gold, Talmi Gold, Chrysorin and Tombac.

From 1800 on, progress in brass making was rapid and continuous. The first successful casting of brass in America by Emerson's process is believed to have been accomplished between 1806 and 1809 in Waterbury, Connecticut. The first successful cold rolling of brass strip was achieved about the same time. By 1830 the brass industry was securely established in this country and several firms were rolling brass strip, primarily for use in making buttons, clocks, stills plated wares and various other articles.

The brasses are unquestionably the most useful of all the copper-base alloys. Essentially, brass is an alloy containing from five to forty per cent zinc, the balance copper. The fundamental characteristics of the various alloys in the family of brasses differ, of course, as the composition changes. Broadly speaking, the brasses may be divided into two groups. The first is the "alpha" group consisting of brasses with a zinc content of approximately 37 per cent or less, the second

TYPICAL PARTS made from copper with copper-base alloys.





COSTUME JEWELRY made from brass.

is the "beta" group comprising brasses with approximately 37 per cent or more zinc.

The alpha brasses are characterized by excellent cold working properties, such as drawing, rolling and spinning, without the need for annealing. They have excellent corrosion resistance and very good electrical and thermal conductivity, these properties generally improving with the increase in copper content. The alpha brasses also have good ductility—their ductility and strength being even higher than that of copper. They may be hot worked with reasonable facility although they are not the equal of the beta brasses in this respect. Typical examples of alpha brasses are: Gilding, Commercial Bronze, Red Brass, Low Brass, Cartridge Brass, and Yellow Brass.

These brasses are fabricated in virtually all of the commercial forms, such as sheet, roll, strip, plate, rod, wire, bar and tube. Some of the principal uses of these alloys are for costume jewelry, compacts, lipstick cases, coins, medals, emblems, shell cases and ammunition components, builders' hardware, architectural trim, automobile radiators, screen cloth, condenser tube, plumbing, process piping, musical instruments, clock and watch parts, and innumerable screws, rivets and other fastening devices.

Generally, the beta brasses have remarkable hot working properties but cannot be cold worked to any great extent. They are characterized by comparatively high tensile strength and good hardness and wearing qualities. Beta brasses are suitable for any application where spinning, drawing or upsetting is not necessary. They are not used where corrosion resistance or electrical conductivity is desired although they are better than many other metals in this respect. Typical examples of the beta brasses are: Muntz Metal, Architectural Bronze and Manganese Bronze.

The beta brasses are available in the same commercial forms as the alpha brasses with the addition of extruded shapes and forgings. They are widely used for condenser tubes and plates, heat exchangers, architectural trim, hardware, clutch disks, pump rods, shafting, valve stems and ships' propellers.

It will be noted that several of the alloys in the alpha and beta groups of brasses are called "bronzes." These alloys are actually brasses although they are commercially known as bronzes, due to tradition and the fact that they have typical bronze colors. The colors of the brasses vary quite widely with the composition from the red gold of Gilding, the "typical" bronze color of Commercial Bronze, to a range of golden shades becoming less red as the copper content decreases, grading to the bright yellow color of Yellow Brass. If the copper content is further reduced the brass takes on a greenish cast; with still further reduction in copper content the color becomes golden again. One of the important reasons for the wide use of the brasses is the range of beautiful colors with which they are characterized. The colors are especially suitable for jewelry, ornaments and such articles as compacts, lipstick cases and cigaret cases.

All of the brasses which have been discussed up to now are known as non-leaded brasses. The family of brasses also include a group of leaded brasses that are intended for free-machining purposes. These are brasses to which one-half to three per cent lead has been added. The lead is not soluble in nor does it enter into chemical combination with the brass; instead, it collects in small particles throughout the alloy. Upon machining, these particles cause the metal being cut off to form into small chips rather than in long spirals, thus freeing themselves readily from the tool. This prevents fouling and dulling of tools and is a very effective means of increasing machinability.

All the leaded brasses may be hot worked but only if the metal is supported mechanically. At high temperatures, the lead within the metal is molten and in the ordinary process of hot rolling or piercing, breakage would occur. However, the materials are as easily extruded or hot rolled as the brasses themselves would be without the addition of lead. Leaded brasses show relatively poor cold working properties. They will all withstand a limited amount of cold work, but as the lead content increases the workability decreases.

The various leaded brasses have different machinability ratings which are arbitrary values that should be considered only as approximate considerations. Many other factors must be considered in addition to the machinability rating. These ratings are based on a comparison with Free-Cutting Brass (containing three per cent lead) which has been arbitrarily assigned a rating of 100. Typical examples of leaded brasses, with machinability ratings shown in parenthesis, are: Free-Cutting Brass (100), High-Leaded Brass (90), Architectural Bronze (90), Leaded Commercial Bronze (80), Forging Brass (80), Medium-Leaded Brass (70) and Low-Leaded Brass (60).

Leaded brasses are available in the form of sheet, roll, strip, plate, rod, bar, tube, extruded shapes and forgings. Primarily used for automatic high speed screw machine parts, these alloys are also used for clock and watch parts, gears, wheels and pinions, instrument dials and plates, hardware, channel plate and screws.

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Reading in Mathematics

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Difficulties in mathematics often are caused by difficulties in English. Pupils do not read understandingly. Instructors must teach English as well as mathematics.

We present here a sound and sensible discussion of such reading difficulties by a skilled and experienced teacher. She makes some valuable suggestions as to what can be done to remedy the situation.

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Reading in Mathematics includes so much that I shall merely sketch some high points of the topic. Much that I have to say is not *new* and may be well known, but I trust that our thinking together on some phases of this problem will stimulate and encourage us to be more alert to, and sympathetic toward, pupils' difficulties in reading mathematical material, especially in verbal problems.

By reading, I do not mean the ability to say words from a printed page. I mean the ability to get the meaning from that page. Reading is an essential tool in a study situation where books and other printed material form a valuable source of information and help.

Naturally, the first question to settle is, Is reading necessary in studying mathematics? or, Why, or for what purposes, do we read in mathematics?

It is trite to say that reading is necessary. We have to read the numbers, the signs, the symbols, to say nothing of, the words on the page. But,—what are the purposes in this kind of reading? Among some twelve that I could name, I shall mention only a few:

1. We read to solve a problem involving quantitative data and necessitating mathematical calculation.
2. We read to gather mathematical data, record, and report them accurately.
3. We read to verify mathematical formulas and symbols in verbal statements.
4. We read to draw generalizations, inferences, and hypotheses from mathematical data.
5. We read to find answers to questions—and so on.

These give an idea as to why we read in mathematics. The ability and skill to read for these purposes must be a part of each pupil's training. We, as teachers, should aim to develop such abilities and skills. Intelligent reading is indispensable to effective participation in modern life. Schools have the responsibility of providing the tools with which pupils can do an efficient job in interpreting the printed matter which they must use.

Boys and girls have been taught reading since their first days in school. Surely, by the time they are high school pupils, they have these reading skills and habits well in hand. It would seem, however, from the educational literature of the time and from observation, that teachers are aware that, among high school pupils, the reading performance is unsatisfactory. One cause of failure and retardation in mathematics is the inability to read understandingly.

Many writers have recognized that this is true. In *Teaching the New Arithmetic* by Wilson, Stone, and Dalrymple, the authors say that "errors in computation are considerably less than the errors in the comprehension of the problem itself."

Dr. Leo Brueckner of Minnesota, an authority in the field of diagnostic study and remedial work in arithmetic, states that diagnostic studies reveal that among the chief causes of difficulty in problem solving are "inferior reading, carelessness in reading resulting in the omission of essential ideas, and misreading . . ."

In the forty-eighth *Yearbook of the National Society for the Study of Education*, Dr. Gray reports, "In former decades, little or no attention was given to reading that arose in content fields. It was assumed that training provided during the reading period developed all the understandings, attitudes, and habits needed by children to engage effectively in required reading. Experience and the results of classroom experiments show clearly that this is not the case. As a result, most teachers are providing guidance in reading in all curricular fields." We hope!

Books in mathematics contain not only quantitative facts, concepts, and processes, but also descriptive, illustrative, informative, and directive passages. All these require a general reading ability and specialized skills peculiar to the subject. A good reader of description or narrative is not necessarily a good reader of mathematics. McCallister in *Remedial and Corrective Instruction in Reading* says, "Mathematical writing utilizes vocabulary, symbols, and modes of expression, the interpretation of which requires concepts and modes of thinking peculiar to itself . . . The development of ability to interpret mathematical material is a significant objective of the teaching of the subject." Another author states that mathematics utilizes material in which facts are closely packed together and intricately woven.

So, if we are to provide the proper guidance to pupils in this type of reading, we must know something about teaching reading. That is: 1. What is included in the reading process? 2. What type of reading and what reading skills are essential to successful mathematical reading? 3. What abilities should pupils have who are to do this reading? 4. What difficulties are encountered by these boys and girls? 5. How can these abilities and skills be developed to be effective?

This would appear to be a large order when these teachers must also teach the mathematical facts and

processes and their accurate manipulation. But, it is a part of the teaching of the subject.

Since mathematical reading involves general reading skills and specialized skills, we must first understand and give consideration to the basic skills and abilities in the general reading process. These are: Recognition and Pronunciation; Comprehension; Organization; Retention; Location; Appreciation; and Use of Ideas. Teachers should have some notion of what these skills are, since every teacher regardless of subject is a teacher of reading. In mathematics these skills must be developed with specific application to mathematical material.

Reading in mathematics is the slow, reflective, deliberative, and intensive type in which every detail of word, symbol, punctuation mark, and the like, plays an important role in the comprehension. Consequently, boys and girls should be taught to be accurate and reflective, being careful to understand each phrase and word. This requires definite and conscious guidance from the teacher and should be included in the lesson plan.

The capabilities and reading levels of the pupils who are to do this reading are other elements of the problem. How often we say, "Well, read the problem." Maybe the pupil just can't read. It is helpful if we have some information on the reading abilities of our pupils. Knowing this will make us more understanding. It behooves us to find out early in the year, by one means or another, a little about how our boys and girls read. Then we can be alert to aid those who have difficulties.

In analyzing the problem further, it is enlightening to know just what difficulties children meet in this type of reading. One writer classifies these difficulties under five headings: 1. Improper methods of attack, such as overlooking significant words, or failure to read the entire phrase, or lack of precision in attention to mathematical facts, or mechanical reading of directions without comprehension; 2. Inability to recognize relations; 3. Inadequate knowledge of the subject matter; 4. Inaccurate reading; 5. Deficiencies in vocabulary. Knowing the difficulties met, we can do something about preventing or overcoming them.

Then, the question arises, Can we justify spending time in teaching reading? A number of studies along this line have been made. In an early study made by F. B. McKnight and reported in the *Third Yearbook of the Department of Superintendents*, he states: "Children's scores in a problem test may be raised as much as a full year through training in reading without any teaching in arithmetic proper." Many other studies emphasize the same point. So, the common belief, and one supported by data, is that definite training in reading will improve work in mathematics.

Up to this point, we have been thinking of reading the printed word. There is more to reading in mathematics than that. We must know how to read numbers and numerals, tables, geometric figures, and the like. Each of these requires a special technique which must be taught. Reading numbers presents trouble, we all know. A study called *How Numerals Are Read* by Terry is interesting. It is a University of Chicago Monograph.

After we become aware that there is a reading problem, that this type of reading requires certain skills and habits, and that there are certain definite difficulties, our next step is to employ such machinery or techniques as will help pupils be adequate readers of mathematics. The knowledge, training, and ingenuity of the teacher will result in devices, procedures, and techniques for use in the class situation where reading is involved.

As a point of departure on techniques, pupils should be instructed to have a purpose in reading, to look for something definite when reading. For example, in an assignment, a statement like this: "When you read page ___ see if you can find anything similar to what we had today. Maybe you can locate a difference." Cole in *Improvement of Reading* states "Children will find meaning in what they read only if they are looking for it . . . If they are instructed to look, their chances of finding it are insured." Further she says, "On the grounds that a pupil should dig facts out for himself, some teachers object to furnishing pupils with this kind of assistance. This process of digging out things for oneself without guidance is a characteristically adult performance."

My objection to high school pupils doing the digging for themselves is that first they should have some tools with which to do the digging. This is also true of college freshmen.

Instructing pupils to look for something definite when reading is part of the assignment. Much has been written on the *assignment*. Teachers should guide the pupils' reading and preparation by means of good direction and clear understandable assignments. Thus, they assist pupils to read for intelligent interpretation.

After pupils are given a purpose or challenge for reading, they should be taught to read the problem or paragraph as a whole, slowly and without trying to understand individual words or phrases. They should re-read it noting words and expressions which they do not comprehend, The teacher, by discussion, use of the dictionary, illustration, or other means, makes certain that all expressions are known. New concepts are explained. Then the pupils should re-read and reflect. They must be made cognizant by illustration or experience that the careless omission of a word or the misinterpretation of a phrase may change the entire meaning of the exercise.

Attention should be directed to any suggestions, hints, footnotes, drawings, or illustrations. All these have a place in comprehension. A procedure of this kind should be a part of the pattern of learning developed consciously by the teacher. It won't come by magic.

The Vocabulary of mathematics—What problems that presents! There are just the ordinary everyday words in different setting, the technical words, the unfamiliar but not technical words, the mathematical phrases or idioms, and combinations of all of these. Certainly youngsters are entitled to help in under-

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A Chemical Show for Younger People

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This is an account of a chemical show for younger people that has been staged successfully by two practicing chemists who are interested both in young children and in the future of chemistry.

The experiments, which are described in detail, have been selected with such care that they can be performed safely almost anywhere. They require no large amounts of dangerous chemicals. Explosions, or flames, or noxious fumes are not involved. Yet the show has high entertainment value.

Here are good ideas for a school auditorium program.

THE INSIGNIA OF THE AMERICAN CHEMICAL SOCIETY.

In the upper triangular half is the figure of a phoenix rising from the flames, typical of chemical activity and of the birth of substance through the energy of chemical change. The piece of chemical apparatus depicted in the lower half is a small Liebig bulb.

The position of the American Chemical Society among professional societies today is second to none. Its efficiency in contributing to the strength and welfare of the nation as a whole depends in no small measure upon the existence of good public relations. Local sections of the Society can make a significant contribution in this field by publicizing the Society to younger people by means of entertainment in the form of a chemical demonstration. A start has been made in this direction by the Northeast Wisconsin Section, and the initial efforts have been very favorably received.

The acceptability of such a show was suggested by the knowledge that some entertainment usually forms part of the monthly Pack meetings of Cub Scouts and parents, and that all too often such entertainment is limited because of budget considerations. A unique opportunity is thus presented to local sections and their members to provide the funds and technical skill necessary for the successful presentation of an entertaining chemical demonstration. Our experience before several such groups in school auditoriums—average attendance about 100—has demonstrated the popularity and enthusiastic reception of such a program. Similar opportunities undoubtedly exist among many other groups, and although the program has been set up especially for younger people, many modifications and extensions are possible. It is the intention of our Section to present a show before any interested group.

The experiments selected for this show differ from most of those described in lay publications in that they require chemicals and apparatus usually found only in the laboratory. In this respect they may be regarded as being more of the professional rather than of the amateur level. In addition, they have been selected so as to minimize hazard and to conform with the strict safety regulations which should apply in school auditoriums. In this connection the amounts of strong acids, alkalies, and other "dangerous" chemicals are kept to a minimum, and no experiments are performed which require the use of heat or flames or which are associated with explosions or the evolution of noxious fumes. It is felt that this aspect of the show for younger people should receive special emphasis, notwithstanding the fact that its observance eliminates the use of many highly spectacular experiments.

THE AUTHORS present the Chemical Show before members of Cub Pack 5 of St. Therese School, Appleton, Wisconsin. . . . Thompson—left.

A prime requirement of all experiments selected is that they possess high entertainment value. Presentation is made in as smoothly flowing a sequence as possible and with a minimum of technical explanation. A little humorous and appropriate patter assists markedly in obtaining a smooth performance. A suitable maxim to follow is "Keep it simple and make it fun," and any approach to the lecture-demonstration type of presentation must be avoided. Interest can be heightened by employing junior assistants from the audience to help with stirring, illuminating, and other simple operations.

The reagents and apparatus are carefully assembled and checked before each performance. The equipment required will depend, of course, upon the particular experiments selected. Our experience indicates that two chemists constitute a satisfactory team. The work involved in assembling and transporting the equipment is then relatively light, and alternation in performing the experiments helps to eliminate "dead spots." A total table surface measuring about 3' by 8' has been found adequate as a demonstration bench. The larger containers used—which include two five-gallon cans for distilled water and a galvanized tub for waste or spent solutions—are kept on the floor and to the rear of the demonstration table. Electricity is the only utility required and this necessitates the possession of a suitable extension cord with multiple outlet. Two 100 watt lamps with reflectors have been found satisfactory for good illumination. Color reactions performed in beakers ranging in size from 1 to 4 liters and with good illumination can be expected to be visible to all members of the audience in an average school auditorium. The use of large test tubes for some of the experiments is often satisfactory. In the case of the "cold light" experiment a large vessel is preferable; a four-gallon pyrex battery jar has been used and found to produce very favorable audience reaction.

The optimum length of a performance is governed largely by audience response. Our experience with groups of Cub Scouts, parents, and friends, indicates that 30 minutes is close to this optimum. The experiments outlined below should be expected to occupy a total time period somewhat in excess of one hour and a certain selection is thus possible.

Red, White and Blue

Production of the three colors, red, white, and blue, from colorless solutions is probably the most widely known of the many magic color demonstrations. Portions of a master aqueous solution containing phenolphthalein, sodium sulfate, and starch, are poured successively into each of three beakers arranged in a row along the front of the table and containing dilute colorless solutions of sodium carbonate for the red, barim chloride for the white, and iodine-potassium iodide for the blue, respectively. The stirring may be performed by three junior assistants from the audience, who are subsequently credited with the color each has so magically "produced." These results may then be compared with those obtained by a second group of assistants (perhaps three of the smallest Cubs present) in the next experiment.

Red, Green, Yellow

Three beakers are arranged along the table front as in the previous experiment and each is nearly filled with a dilute solution of sodium dichromate (lightly colored). To the two outer beakers are then added with stirring a few drops of a concentrated solution of silver nitrate and of lead acetate respectively to produce brick-red silver chromate and chrome yellow. These precipitates are compared with the original color remaining in the middle beaker. To this latter is then added a little solid sodium sulfite and a few drops of mineral acid to yield the dark green of chromium sulfate.

Red Cabbage

A color experiment more closely associated with the home may be performed with one or two leaves from a red cabbage. These are shredded or pulped in the presence of a little water by means of a Waring Blendor or other device. The resulting slurry is filtered through a coarse filter (paper towel) and the filtrate diluted as required to yield a light tint. The indicator colors of the extract—similar to litmus—are then demonstrated by using dilute acid and alkali. Beet juice and grape juice may also be used.

Thymol Blue

The laboratory indicator Thymol Blue may be used in a manner similar to that described for the cabbage, beet, and grape juices. A few drops of the indicator solution in 1 or 2 liters of water containing a little alkali produce a bright blue solution. Gradual addition of acid takes the color through yellow to pink, and the process may be reversed by the addition of alkali.

Sawdust

A colorful demonstration with sawdust is based on the Mäule reaction. Some sawdust (or shavings) from a deciduous wood (poplar, elm, maple, gum, etc.) is placed in a large test tube or other reaction vessel with chlorine water and shaken for a minute or so; an excess of solid sodium sulfite is then added and a bright red color gradually appears. In the case of coniferous woods (spruce, fir, hemlock, larch, etc.) a rather indifferent yellow or light brown color is produced. The colors result from reactions with the lignins of the woods and serve to distinguish between deciduous and coniferous species.

Paper

The intense purple color which results when phloroglucinol reacts with lignins may be used as the basis of an interesting demonstration with papers. The reagent consists of a 5 per cent solution of phloroglucinol in ethanol to which is added an equal volume of concentrated hydrochloric acid. Papers containing lignin, e.g., newsprint, paper towels, etc., will yield the color rapidly whereas those essentially free from lignin, such

as bond writing papers and especially rag papers, remain colorless when treated with the reagent.

Ammonia Fountain

This spectacular and well-known demonstration is based on the great affinity for water of a highly soluble gas. Prior to the show a five-liter round-bottom flask is filled with dry ammonia gas through an inlet tube which extends through a rubber stopper to within an inch of the bottom of the flask. The end of the tube in the flask is tapered to form a jet and the outer end is closed with a rubber bulb from a medicine dropper. An appropriate over-all length for this glass tubing is about 3 feet. The fountain is started by inverting the assembly and supporting the flask on a ring stand so that the outer end of the tubing—still closed by the rubber bulb—is immersed in a trough of water containing a little phenolphthalein. Upon removing the rubber bulb the water rises in the tube to form a pink fountain at the jet.

Starch-Iodine

The intense and beautiful blue color obtained with starch in the presence of iodine can form the basis for a number of interesting demonstrations. The addition of a few drops of an aqueous solution of iodine in potassium iodide to a slice of bread or potato, to flour or a starched shirt cuff, etc., suggest themselves at once. (Does a potato feel blue when its cuts are treated with iodine?) Subsequent decolorization with aqueous sodium thiosulfate provides a natural and interesting sequel. A demonstration can be built around the accidental spilling of tincture of iodine on mother's best linen table cloth. Attempts to remove the iodine stain by ordinary laundering methods are not satisfactory and domestic tranquility is not restored until thiosulfate solution is used. This color reaction may also be utilized in the "clock reaction" outlined below.

Clock Reaction

In clock or time reactions a definite period of time elapses after the reagents are mixed and before an indication of chemical change appears. The reaction of sulfurous acid with an iodate in the presence of starch was used with success in our show. It will be recalled that several successive reactions are involved and that iodine is liberated only when all the sulfur dioxide is used up. Careful control of concentrations permits the accurate prediction of the induction periods—of the order of one minute—which transpire before the blue color appears. The demonstration may thus be treated as a "chemical chronometer" and used to check the accuracy of watches in the audience. Experimental details are to be found in an article by W. J. Conway in the *Journal of Chemical Education* of August, 1940, on page 398.

Invisible Writing

A very satisfactory demonstration of invisible writing may be achieved by employing a chemical reaction involving the partial reduction of ferric ferricyanide to yield Prussian Blue. Prior to the performance, an invisible image—topical in character—is painted on white wrapping paper of suitable dimensions with a small paint brush and an alcoholic solution of vanillin. The blue image is then later developed by dipping the paper into a solution of ferric ferricyanide freshly prepared from 1 per cent solutions of ferric chloride and potassium ferricyanide.

"Milk" to Rubber

The coagulation of a rubber latex—natural (Hevea), or a synthetic such as neoprene, or GR-S—with alum may be used as the basis of an interesting experiment. The milk-like character of the latex (about 50 per cent solids) is first demonstrated by the ease with which it pours from one beaker to another. A little alum (30 per cent solution) is then added to produce partial coagulation, and elastic strings of the rubber are drawn from the beaker with a stirring rod or, alternatively, sufficient alum may be added to coagulate all the latex and the rubber then lifted out as a single piece which retains the shape of the container. The solid may be squeezed to remove excess liquid and then rolled between the palms of the hands to form a "golf ball"; the elastic properties of which are demonstrated by bouncing it on the floor.

Cold Light

The most spectacular demonstration of the entire show is probably the cold light experiment, and it is therefore used for the closing climax. The reaction is readily and simply brought about, and involves the oxidation of luminol (3-aminophthalhydrazide) in dilute sodium hydroxide solution with hydrogen peroxide and potassium ferricyanide. Two solutions are prepared prior to the show as follows: 1 gram of luminol in 100 ml. of 5 per cent sodium hydroxide solution, and 2.5 grams of potassium ferricyanide crystals in 100 ml. of 3 per cent hydrogen peroxide. The reaction is most effectively performed in a completely darkened room by pouring these two solutions simultaneously into about 14 liters of water contained in a large glass battery jar. A piece of ice may be placed in the water prior to the mixing of the two solutions to show that the light is produced at low temperatures. After the initial mixing, solid potassium ferricyanide or alkali may be added as desired to vary the intensity of the light. Acidification of the solution will stop the light, which may then be restarted by adding alkali. Further details are to be found in an article by Huntress, Stanley, and Parker in the *Journal of Chemical Education* of March, 1934, on page 142.

The phenomenon may be compared with the well-known illuminating ability of the firefly, and the intensity of the light may be indicated by the ease with which printed matter may be read in the close vicinity of the reaction vessel. ●

Formaldehyde, -- Chemistry and Application

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Formaldehyde, the simplest but the most highly reactive and most versatile of the aldehydes, is one of the world's most useful manufactured chemicals.

Since it enters into many types of reactions, it finds numerous uses. The synthetic resins industry utilizes three-fourths of the billion pounds of formalin the United States produces annually. The remainder is used in the drug, textile, paper and leather industries and as a disinfectant and preservative.

In this paper you will find information, useful facts, and interesting chemistry.

Introduction

Formaldehyde, first in the aldehyde homologous series, is manufactured in larger quantities than any of the other aldehydes. Its major usage is in the synthetic resin industry, which consumes over three-fourths of the formaldehyde production.

At room temperature, formaldehyde [CH_2O], is a gas. However, it is unstable in this form and tends to polymerize to a hard, horny polymer known as paraformaldehyde. For this reason, almost all of the formaldehyde, up until the last few years, was sold as a 37 per cent aqueous solution. Recently, a low price paraformaldehyde, of low polymer length and high reactivity, has been made available in commercial quantities. This form of formaldehyde is sold either as a solid flake containing 91 per cent formaldehyde and 9 per cent water or in an alcohol solution containing 40 per cent formaldehyde, 51.5 per cent alcohol and 8.5 per cent water.

History

Formaldehyde was first prepared by the Russian chemist A. M. Butlerov in 1859, quite by mistake as he was attempting to prepare methylene glycol by the hydrolysis of methylene diacetate.

Although he did not realize that he had prepared an aqueous solution of formaldehyde, his synthesis cannot be questioned since he prepared and described both paraformaldehyde (the linear polymer) and hexamethylenetetramine (the reaction product with ammonia).

In 1868 formaldehyde was deliberately synthesized by A. W. von Hoffman via the air oxidation of methanol over a platinum catalyst.

$$CH_3OH + \text{air} \xrightarrow[\text{catalyst}]{} CH_2O$$

Commercial production was first initiated in Germany around 1888; however, it was not until the development of phenolic resins in 1910 that large scale production was begun.

Manufacture

The annual U. S. production of 37 per cent formalin for 1952 was estimated to be slightly over one billion pounds with a total capacity of approximately 1.75 billion pounds. By 1956 it is estimated that total U. S. production will be 1.5 billion pounds of formalin. At the present time only 40 per cent of all production is available for sales. The other 60 per cent is consumed by producers in their own manufacturing processes. The following are believed to be the ten largest manufacturers of 37 per cent formalin.

Company	Process	Plants
1. E. I. duPont	Methanol Oxidation	Belle, W. Va.
E. I. duPont	Methanol Oxidation	Toledo, Ohio
E. I. duPont	Methanol Oxidation	Perth Amboy, N. J
2. Heyden	Methanol Oxidation	Garfield, N. J.
Heyden	Methanol Oxidation	Fords, N. J.
3. Celanese Corporation of America	Gas Oxidation	Bishop, Texas
4. Carbide & Carbon Chemical Corp.	Methanol Oxidation	Bound Brook, N. J.
5. Monsanto Chemical Company	Methanol Oxidation	Springfield, Mass.
6. Allied Chemical & Dye Corp.	Methanol Oxidation	South Point, Ohio
7. Rohm & Haas	Methanol Oxidation	Bristol, Pa.
Rohm & Haas	Methanol Oxidation	Bridesburg, Pa.
8. Durez Plastics & Chemicals	Methanol Oxidation	N. Tonawanda, N. Y.
9. Spencer Chemical Company	Methanol Oxidation	Calumet City, Ill.
10. Borden Company	Methanol Oxidation	Bainbridge, N. Y.

It is of particular interest to note that of the above producers, only Celanese utilizes natural gas as a raw material. In the advent of a national emergency, at least one producer would be independent of methanol, a critical material during such a period.

Major Uses

It is estimated that 75 per cent of all the formaldehyde produced is consumed directly by the resins industry, and 10 per cent for the manufacture of pentaerythritol ("PE") and hexamethylenetetramine ("Hexa"). Since "PE" is used for the preparation of thermosetting alkyd resins and "Hexa" is used as a curing agent for phenolic resins, formaldehyde demand is almost wholly tied to the resin industry.

The remaining 15 per cent is distributed among a variety of end uses, such as drug, textile, leather, paper, embalming fluids and disinfectants. As a deodorant, formaldehyde has questionable deodorizing properties; however, there is no question as to its ability to eliminate the sense of smell.

Physical and Thermal Properties

The following is a list of the physical and thermal properties of anhydrous formaldehyde gas.

Odor	Strong, pungent
Freezing Point	—118°C
Boiling Point	— 19.2°C
Heat of Polymerization	15 kg-cal.
Explosive Limits	
% by Vol. in air, lower limit	7.0
upper limit	73.0
Auto-ignition Temp.	Approximately 300°C
Heat of combustion (gram-mole)	134.1 kg-cal.
Heat of Formation @ 18°C (gram-mole)	28.3 kg-cal.
Free energy (gram-mole)	27.0 kg-cal.
Heat Capacity @ 760 mm Hg (gram-mole)	
0°C	9.75 kg-cal.
100°C	10.49 kg-cal.
Heat of Solution in water (gram-mole)	15 kg-cal.
Solubility	Readily soluble in water and polar solvents. Only slightly soluble in non-polar solvents.

Formalin

The properties of formaldehyde in water are of special interest, since the major portion is sold as the 37 per cent aqueous solution.

When dissolved in water it reacts to form an equilibrium mixture of the dissolved monohydrate, methylene glycol [$CH_2(OH)_2$] and a series of low-molecular weight polymeric hydrates of the following general formula $HO(CH_2O)_nH$.

Under certain conditions, it is possible that unhydrated monomeric formaldehyde may exist as such in solution. The more concentrated the solution the higher the degree of polymerization of the formaldehyde. On the other hand, higher temperatures produce solutions in which the formaldehyde polymers are of low molecular weight. Since polymers having a degree of polymerization greater than three are only partially soluble at room temperature, uninhibited formalin (37%) must be stored at an elevated temperature.

Increased stability at low temperature may be obtained by adding methanol to the formalin. This results in the formation of hemiacetals, $CH_2(OH)(OCH_3)$, and reduces the degree of polymerization. An inhibited grade of formalin (37%) sold commercially which contains 7-8 per cent of methanol may be stored at 60°F., whereas the uninhibited grade should be stored at a temperature not lower than 95°F. Fifty per cent uninhibited formalin must be stored above 150°F.

The partial pressure of formaldehyde in aqueous solutions is a function of the methylene glycol concentration, and in the vapor state its partial pressure can be taken as the decomposition pressure of the dissolved hydrate. Therefore, formaldehyde solutions may be concentrated by vacuum distillation at low temperature, or concentrated distillates may be obtained by pressure distillation at high temperatures. When formaldehyde water vapors are fractionally condensed, the uncondensed vapor increases in formaldehyde content as the water is the least volatile constituent of the mixed vapors.

Formcels

Formaldehyde-alcohol solutions (Formcels) are water-white solutions of formaldehyde dissolved in an alcohol. They provide a convenient source of nearly anhydrous formaldehyde. Chemically, they are a mixture of hemiacetals of monomeric and polymeric formaldehyde and the alcohol employed.

Formaldehyde concentrations up to 55 per cent in methanol are commercially available and are stable above 60°F. Should precipitation occur in the Formcel Solutions, solution may be re-established in a short time by heating at 150°F.

Formcels are available in propyl, isobutyl and n-butyl alcohol, as well as in methyl alcohol. Stability seems to decrease with increasing chain length and branching of the alcohol.

Paraformaldehyde

The straight-chain polymer of formaldehyde, [$HO(CH_2O)_nH$], in which n is usually greater than five is known as paraformaldehyde. The material is a horny white solid supplied either as a flake or powder. The common paraformaldehyde ("Paraform") is supplied as the flake having a minimum CH_2O content of 91 per cent and an average n value of approximately 10. The remaining 9 per cent is water either in the free state or combined with the polymeric formaldehyde to form a hydrate.

Upon prolonged standing, paraform polymers gradually increase in chain length. This increase results in a transfer of combined water to free water, followed by a loss of free water through evaporation. The assay (formaldehyde content) increases slowly to approximately 94-95 per cent CH_2O, and then remains constant. Under normal storage conditions this loss of water and increase in assay takes over a year, and is of little concern to the user.

There are available several special grades of paraformaldehyde which assay 95 to 99.9 per cent formaldehyde content. As the assay increases, the formaldehyde polymers increase in chain length and the paraform becomes less water soluble and reacts more slowly.

The solubility of paraformaldehyde is a function of the polymer size. Low molecular weight polymers are more soluble than the higher molecular weight polymer. For a given polymer size, solubility increases with temperatures. The pH has a marked effect on solubility. At low pH's (less than 1) or high pH's (greater than 12) paraformaldehyde is readily soluble in hot water. However, at a pH between 3 and 5 paraformaldehyde is difficulty soluble.

The physical properties of flake paraformaldehyde are as follows:

Appearance	Hard, Pulverable Flakes
Color	White
Odor	Formaldehyde
Bulk Density (Approx.) lbs/cu. ft.	40.6
Melting Point (Sealed Tube)	100° — 125°C
Flash Point (Tag open Cup Approx.)	200°F
Ignition Temperature (Aprox.)	575°F
Flammability	Combustible Solid
Explosive Limits (Pure Formaldehyde Vapor)	
Lower Limit (by vol. in Air)	7.0%
Upper Limit (by vol. in Air)	73.0%
Specific Gravity	1.39
Molecular Weight (Oxymethylene Groups Ave.)	10
Heat of solution to dilute solution (5% concn.)	—2.5 K cal. per mol max.
Methanol Content	None
Color (APHA as 37% soln)	10
Particle Size	Passes ½ inch screen
Vapor Pressure	

Varies with humidity being lowest under anhydrous conditions and increasing to a maximum at the dew point (all figures in mm Hg.).

@ 30°C	Dry Air	1
@ 30°C	Dew Point	3
@ 60°C	Dry Air	5
@ 60°C	Dew Point	15

Paraform rapidly sublimes above 150°C

s—Trioxane

The symmetrical cyclic trimer of formaldehyde, known as trioxane, is a stable, colorless solid. It has a chloroform like odor and sublimes to form tough, pliant, rhombohedric needles. Trioxane may be distilled at atmospheric pressure with no decomposition.

Acids cause trioxane to depolymerize to monomeric formaldehyde. The depolymerization may be accomplished in aqueous or non-aqueous solutions as well as in the vapor phase. The rate of depolymerization may be controlled by the concentration of the acid, the type of acid and the temperature. Strong mineral acids are more effective than most organic acids and higher temperatures cause more rapid break-down. Friedel-Craft type catalysts such as aluminum chloride also accelerate the depolymerization. When trioxane vapors are passed over an acid type catalyst on a suitable carrier at elevated temperature it decomposes to monomeric formaldehyde. It is a source of anhydrous formaldehyde.

Trioxane has the following physical properties:

Appearance	Colorless Crystals
Odor	Ether-Alcohol
Molecular Weight	90.08
Melting Point, °C	62
Boiling Point, °C	115
Vapor Pressure, mm Hg. @25°C	13
Specific Gravity, Molten @65°C/20°C	1.17
Flash Point, tag open cup, °F	113
Heat of Combustion, Kcal/g. @23°C	3.96
Explosive Limits, % by volume in air	3.5 to 28.7
Heat of Sublimation, Cal/g.	150
Heat of Vaporization, Kcal/mol @114°C	9.8
Specific Heat, gram cal/g./°C	0.22

Trioxane is used by the armed forces as a field heat ration. It burns with a steady nonluminous flame and the products of combustion are non-toxic. Trioxane fuel tablets may be readily lighted at −40°F.

Reactions of Formaldehyde

Formaldehyde is probably the most reactive and versatile aldehyde. It reacts with almost every type of chemical with the exception of the paraffins. It is readily available as a solid, (in the form of a straight chain polymer or cyclic trioxane), in alcoholic solutions, and in aqueous solution. Monomeric formaldehyde may be obtained from either of the solid forms by simple vapor phase catalytic depolymerization.

Formaldehyde may be reduced to methanol:

$$CH_2O + H_2 \longrightarrow CH_3OH$$

or oxidized to formic acid:

$$CH_2O + O_2 \longrightarrow HCO_2H$$

It undergoes auto-oxidation-reduction in aqueous solution to yield formic acid and methanol (Cannizzaro reaction).

$$2CH_2O + H_2O \longrightarrow HCO_2H + CH_3OH$$

This reaction accounts for the build-up in acidity of formalin on storage. Paraformaldehyde does not undergo this reaction.

The type of reaction which formaldehyde undergoes is generally controlled by the catalyst. Acid catalysts promote formation of methylene derivatives, and alkaline catalyst methylol derivatives. In most cases the methylol groups undergo further condensation with an active hydrogen which results in a methylene linkage.

For example, with urea there is first formed dimethylol urea followed by condensation when the reaction is made acidic.

$$(NH_2)_2CO + CH_2O \xrightarrow{OH^-} (HOCH_2NH)_2CO$$

$$n\ (HOCH_2NH)_2CO \xrightarrow{H+} \left[-CH_2NHCO\underset{\substack{|\\CH_2OH}}{N}-\right]_n$$

In the case of the urea-formaldehyde reaction a tetrafunctional molecule is produced.

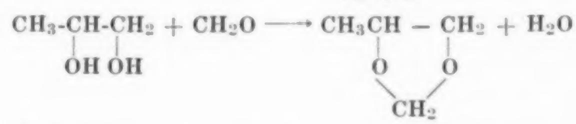
The reaction of formaldehyde with phenol is of major importance in the manufacture of synthetic resins and phenol-formaldehyde adhesives. Formaldehyde reacts with phenol under acid conditions to form a thermosetting resin, and under alkaline conditions to give liquid adhesives.

The reaction of phenol and formaldehyde to make a practical resin was first patented by Baekeland in 1909. Baekeland's initial work involved the reaction of formaldehyde with phenol under alkaline conditions to form an infusible resin, in three stages. The first stage, Bakelite A, is a liquid or semi-solid. Continued heating converts Bakelite A to Bakelite B, which is a relatively insoluble fusible solid. When Bakelite B is subjected to heat and pressure, an insoluble and infusible resin, Bakelite C, is produced.

More modern practice calls for the initial reaction of formaldehyde with excess phenol under acid conditions to form a Novolak. A Novolak is a "second stage" condensation product, which is a solid-fusible resin. The Novolak is then mixed with "hexa" and suitable fillers. Upon subjecting this material to heat and pressure a solid infusible resin is produced. In this manner the ordinary phenol formaldehyde plastic articles are manufactured.

Formaldehyde reacts with alcohols and glycols under acid conditions to form linear and cyclic formals.

$$CH_2O + CH_3OH \xrightarrow{H+} \underset{\text{Methylal}}{CH_2(OCH_3)_2} + H_2O$$



Under neutral or alkaline conditions hemi-acetals are formed.

$$[CH_2(OH)(OCH_3)]$$

Formaldehyde and hydrogen chloride react with aromatic compounds to give chloromethylated derivatives.

$$\underset{\text{Benzene}}{C_6H_6} + CH_2O + HCl \longrightarrow \underset{\text{(Benzyl Chloride)}}{C_6H_5CH_2Cl} + H_2O$$

(Continued on Page 142)

Magnificat

By SISTER M. ELIZABETH MICHAEL, O.P.

I am bowed
  in Gloria Patri posture
  over a microscope.
And not my body only
  is poised in adoration
    for
  my mind is on its knees.
"It is truly meet and just"
  that we assume this attitude of awe
  as reverently we read
  this single-celled apocalypse,
  and listen to a protozoan preach on Providence.
For, while mechanized eyes penetrate the mystery of matter,
  deep within me
  Faith focuses on Another Specimen.
The gaze of contemplation
  (most powerful of all oculars)
  dares to pierce the very mind of God
  and trace with trembling thought
  the fantastic physiology of
    Love.
The source of Motion we find in the Immutable,
  He is not moved—He is the Mover.
He has Adapted Himself to every idiosyncrasy
  of human frailty
  Just to be One with us.
He is Nourished with a hunger
  for the starving souls of men.
  And to satisfy that hunger
  He becomes our Food.
The breath of Life in rhythmic Respiration
  Flows by divine Diffusion
  from the area of highest concentration
  which is the Heart of Christ!
His Response to every Stimulus
  is instant and intense.
  And His response is always and inexorably
    Love.
In every living creature He has Reproduced
    Himself
  In multitudinous image of His Infinite Variety.
  But only in the souls of men
  is God Himself the Father and the Child.
This is the mystic metabolism
  by which, (destruction with a Purpose)
  I am born in the death of God—
  and Christ is born in mind.
A microscope can magnify
  but more—
In union with my singing soul
  My microscope "doth magnify the Lord!"

MAGNIFICAT was written by Sister Elizabeth Michael after a study of fundamental life functions in a class in biology conducted by Sister M. Walter, O.P., at Caldwell College, Caldwell, New Jersey. She now teaches at St. Michael's School, Union, New Jersey.

NEW BOOKS

Principles of Organic Evolution

• *By* ARTHUR WARD LINSEY. St. Louis: C. W. Mosby Company. 1952. Pp. 375. $5.75.

The table of contents of this book lists an Introduction, A History of Evolution, and five units as follows: Relationship of Organisms, four chapters; Evidences of Evolution, two chapters; The Evolution of Existing Forms, five chapters; The Process of Evolution, seven chapters; and The Importance of Evolution in Human Life, one chapter.

The book was written to meet the needs of "those who want to know something of the subject as a part of liberal education" and for "those whose interest is seriously scientific."

The book is difficult to read because of the style of writing used by the author. The sentences are long and involved. The author has a tendency to repeat many times. The choice of words in these repetitions leads to confusion rather than to clarity. The book appears to be the wordy first-draft of the author's ideas pertaining to changes in plants and animals. When one tries to edit the text with a view to sharpening concepts one finds contradictions. It is not apparent to this reviewer whether the contradictions are due to sentence entanglements or to an irregular use of terms.

The classification of plants used in this text is generally considered to be out-of-date. The geologic time chart given on pages 126 and 127 differs from the classical charts in that both Archeozoic and Proterozoic eras are included in one era called the Cryptozoic, and the Cenozoic era is followed by an era called the Psychozoic.

It would seem that this book does not fulfill well the aims of the author.

Helena A. Miller, Ph.D.
Department of Biology
Duquesne University

Laboratory Experiments in General Chemistry and Semi-Micro Qualitative Analysis

• *By* GEORGE W. WATT and L. O. MORGAN. New York: McGraw-Hill Book Company, Inc. 1953. Pp. 228, Paper, 8½ x 11. $3.50.

A laboratory manual designed to meet the needs of a two-semester introductory college chemistry course.

Part one consist of 49 experiments in general chemistry. While the experiments do not differ appreciably from the usual freshman experiments, the authors have very wisely included a greater proportion of basic quantitative experiments than is usually found in such manuals.

Part two covers briefly the usual semi-micro scheme for cations and anions. The qualitative analysis coverage while suitable for students who are taking a terminal course in chemistry leaves much to be desired in a course designed for chemistry majors.

J. Moroney, C.S.Sp.
Department of Chemistry
Duquesne University

Dictionary of Games

• *By* J. B. PICK. New York: Philosophical Library. 1952. Pp. 318. $4.75.

Here is an interesting compendium of "the best competitive games played in Britain." It tells how to play 458 games, many of them unfamiliar to Americans, at least under the English names. The games are arranged alphabetically under five headings: Full-Dress Outdoor Games, such as baseball ("glorified rounders or an extraordinary American war-dance performed in knickerbockers"); Informal Outdoor Games, such as Hit the Basket ("a French cricket variant—much less interesting"); Covered Court Games, including skittles (bowling); Gymnasium Games, such as Ground Ball ("this game would be called football but for the anatomical paradox"); and Indoor Games including chess, darts, canasta, musical chairs and murders ("a word and dirty-deed game of great fascination").

This book is a valuable dictionary of rules for the teacher who directs games, for the party giver, and even for the harassed mother on a rainy day.

H. C. M.

Spadework in Archaeology

• *By* SIR LEONARD WOOLLEY. New York: Philosophical Library. 1953. Pp. 124. $4.75.

This very readable, non-technical story by a famous field archaeologist tells about his first excavations in England, Nubia, and Egypt, and his later digs in southern Italy, Mesopotamia, and Syria. He reminisces about the people he has met, and recalls the places in which he has made interesting finds during the past fifty years. His tales are well told. The reader learns of the planning that precedes an actual dig, the numerous difficulties that may be encountered, the part that chance plays, and the joy of discovery. There are thrills and excitements and disappointments. The writer makes archaeology come alive. The book can be finished in an evening. Reading it is very much worth while. There are a large number of detailed drawings and maps, and more than a dozen beautifully reproduced photographs.

H. C. M.

Between the Tides

• *By* PHILIP STREET. New York: Philosophical Library. 1953. Pp. 175. $4.75.

An interesting introduction to the natural history of the seashore. The biology teacher will be glad to have this book in his high school library. Written primarily for teenagers, it will hold the attention of readers of all ages. The author has written a clear, non-technical account of some of the more common living animals that may be found by searching the beach at low tide. Snails, crabs, barnacles, mussels, star-fish, prawns, shrimp, sponges, shore fish, and many others are described. Representative types are studied and simple methods of identification employed. Special lines of investigation are suggested. A chapter is devoted to shore weeds since these often furnish shelter or food or a place of attachment for the animals. The large number of clear photographs which illustrate and amplify the text were made by the author.

H. C. M.

A Popular Guide to Government Publications

• *By* W. PHILIP LEIDY. New York: Columbia University Press. 1953. Pp. XXII + 296. $3.00.

Who is the world's largest publisher? Who publishes best sellers at ten and fifteen cents? Whose publication list includes titles that touch practically every phase of modern life? What publisher is always concerned more with service than with profit?

The United States Government, of course.

In a way, this book is an eye-opener. Here one learns of the great amount of helpful material that can be obtained from the Government Printing Office at a nominal cost. The book lists some 2500 titles, under 100 or more subject headings as diverse as agriculture, music, citizenship, fire fighting, games and recreation, forestry, atomic energy, health, house plans, art, plumbing, surveying and wild life. Only late and active publications of wide appeal and usefulness are included. The title, cost, and order number of each are shown. This book will be of enormous aid to the teacher. It should be on every farm and in every home.

H. C. M.

Succulent Plants (Other than Cacti)

• *By* A. BERTRAND. New York: Philosophical Library. 1953. Pp. 112. $4.75.

The remarkable forms and the fantastic beauty of succulent plants belonging to a number of families are described and pictured in this most attractive and highly informative book. Cacti have been omitted since these plants were considered by the author in a previous book, "Cacti." Here he discusses fleshy-leaved plants that have adapted themselves to living under difficult circumstances in many parts of the globe. Some are storehouses for water and nourishment to be used later; others have hard, tough, waxy skins to protect against evaporation. This book, however, restricts its study to those which have horticultural interest because of their beauty or their unusual appearance.

There is an introductory chapter considering the plants in their natural environments. This is followed by chapters on cultivation and propagation. The enemies of succulent plants are considered. There is a brief Glossary and an Index. The 39 plates in monochrome and the 23 full color plates are superbly done.

H. C. M.

Survey of Biological Progress, Volume II.

• *By* GEORGE S. AVERY, JR. New York: Academic Press, Inc. 1952. Pp. 333. $7.00.

This second volume contains eight articles on unrelated subjects in Biology. Each article represents a summary of recent work in a given field of specialization presented so that those in unrelated or marginal fields of specialization may have an understanding of what progress is being made.

The subjects presented in this volume are: Effects of Radiation on Biological Systems; Progress in Human Genetics; Biological Oceanography; Morphogenesis in Plants; The Control of Plant Growth by the Use of Special Chemicals with Particular Emphasis on Plant Hormones; Histochemistry; The Fine Structure of Protoplasm; and Physiology of Reproduction in Plants.

Every one of these articles is well worth the time and effort required to read it. Each author has listed a good selection of references. At the end of the volume appear both an author index and a subject index.

Those who are interested in integrating Biology, especially those who teach Biology, will find these articles invaluable.

Helena A. Miller

Man and the Biological World

• *By* J. SPEED ROGERS, THEODORE H. HUBBELL and C. FRANCIS BYERS. New York. McGraw-Hill Book Company, Inc. 1952. Pp. 690. $5.75.

This is the second edition of a textbook written for a survey course in Biology for the first- and second-year college student.

The book has four parts: Part I, The Individual Organism, A. The Human Body, B. The Individual Plant, C. The Varied Patterns of Individual Organization; Part II, The Continuity of the Race, A. Reproduction, B. Inheritance and Variation; Part III, The Changing Generations—The Evolution of Life in Time and Space; Part IV, The Economic and Social Interrelationships of Organisms.

Emphasis is placed on man to the extent that more than one-half of Part I is devoted to a consideration of the structure and functions of the human body, while the other half of Part I is divided between a consideration of the structure and functions of higher plants and a discussion of organization in all other organisms. A similar emphasis on man exists in Part II, dealing with the continuity of the race. Part III, the largest of the four parts, comprises about one-third of the entire book. This part is up-to-date and is presented in a reasonably objective fashion. A great deal of the discussion is centered about the evolution of man and his races about which the authors admit there is very little concrete evidence. Part IV is well organized, but is very brief, being compacted into fifty pages.

The authors are generally careful in the choice of words and in phrasing concepts objectively, although there are a few exceptions. The illustrative material and the legends which explain it are of a good quality for a textbook of this nature.

It would seem to this reviewer that this book would be improved if it were modified as follows: 1) a little more emphasis given to the structure and functions of animals other than man; 2) more emphasis given to the structure and functions of plants; 3) less emphasis and space devoted to the evolution of man and his races; 4) the information and concepts in Part IV expanded, thus making it more easily understood by underclassmen.

Helena A. Miller

Science and Society

(Continued from Page 123)

freeze-dried bones, skin and eye-cornea tissue in patching up diseased or injured people is now well-established. The temporary use of an artificial heart or an artificial kidney has been accomplished either in man or in experimental animals, and is presumably on the way to being routine procedure. The large scale use of entirely artificial blood-plasma is actually going on today. In fact, surgery seems to be at the door of long corridors of advancement in patching up bodies with spare parts and replacements.

And internal medicine has equally intriguing prospects ahead. The quinine derivatives and the sulfa drugs were wonderful enough, but the antibiotics have opened such enormous possibilities—may I pause here to say that the antibiotics furnish a good example of the utter unexpectedness and unpredictability of research and scientific progress which I mentioned above —that we may some day be living in a germless environment, like the experimental germless animals at Notre Dame University.

One thing we must keep in mind. The Martian creatures who invaded Earth in the tale by H. G. Wells, made famous a few years ago by Orson Wells, died off quickly in our bacteria-laden world because their own environment on Mars had been sterile so long that they had lost all power of resistance. And, in sober truth, the germ-free animals at Notre Dame do have low resistance and die off quickly when brought out into the dirty, deadly world. So every time we blot out another disease in the modern sphere of life, we may be storing up more trouble for our descendants.

This little discussion about food and medicine has supplied examples of how science and scientific effort are impinging on daily life. The same sort of thing goes on daily in the other fields vital to our race. In transportation, in communication, and unfortunately in military affairs, science is making the world over, and by my prediction, it will be a continuous process. We are embarked on the wings of change and only God knows when we will come to rest. Man has taken to himself great power and great responsibility to use that power for good.

The third chapter of Genesis recounts how the serpent said to the woman that if she and the man should eat of the fruit of the tree of knowledge "You shall become as gods, knowing good and evil." Well, they ate and we now have knowledge of good and evil, and in some strained sense are as gods. It is our choice to use our knowledge and our powers for good or for evil. I choose to think that it will be for good. ●

★ ★ ★ ★ ★

Criticism of the past has value in stirring up interest and discussion, and although we cannot change the past, we can shape a better future by learning to avoid what we recognize as error.

—EDWARD FARBER
The Evolution of Chemistry

Reading in Mathematics

(Continued from Page 128)

standing these. This vocabulary must be taught in the mathematics class by whatever procedures the teacher finds best. No one device is THE best. What may be good in one class may not work with another. What produces successful results for you may not work for me. However, we can get ideas from devices which have been used by other teachers.

Lists of words, technical, ordinary, unfamiliar, and the like, should be prepared by the teacher and perhaps put on the blackboard or mimeographed. Pupils should pronounce, spell, discuss the meanings, use, illustrate, and look up in the dictionary. Any procedure which will impress the meaning and use of words is good. Pupils can make their own lists. Sometimes before a lesson is given, I put new words on the board for study and discussion. Then they are read in context, and further explanation may be needed. I, again, may tell pupils to read a paragraph which they have not had before, and find any expressions which they do not know or understand.

The use of drill to fix words, facts, and so on, is recommended provided such drill has a definite need and aim.

Several other thoughts come when thinking of teaching mathematics. Among these are: verbal problems and following directions. Much has been written on methods of interpreting verbal or word problems. Little needs to be added except to say that after the problem has been interpreted, care must be exercised in translating the words into symbols and expressions which are mathematically correct and grammatically right. For example, in algebra, say, "Let x = no. mi. per hr., not = 'rate'."

Training in following directions is important in the reading and in every part of the mathematics program. This training must be definite and specific not incidental. The accurate reading and listening to directions and the careful fulfillment of them are ever present parts of the lesson. This ability is a demand of the business world of today.

There are some other interesting phases of the teaching of mathematics, such as the computation and construction, the pupil, the teachers. Space will not permit reference to these.

I wish, however, to mention a few examples of problem difficulties from tenth, eleventh, and twelfth grades and from Veterans' work, in which a lack of understanding of words or phrases hindered computation:

1. Algebra—
   a. The square of the sum of two numbers *or* The sum of the squares of two numbers;
   b. The denominator exceeds the numerator by ____.
2. Geometry—
   a. Chords *intercept*;
   b. A line and a point *without* the line;
   c. A perpendicular FROM a point to a line.
3. Mathematics Review for twelfth grade.—
   a. What do "Annex," "Competent," "Per capita," "Digit" mean?
   b. A picture 121/2 inches long and 81/4 inches wide is put in a frame 21/4 inches wide *outside* the picture. What are *dimensions* of the frame?
4. Trigonometry—
   From the top of a hill, the angles of depression of *two successive milestones* in the same vertical plane as the observer are $20°37'$ and $17°11'$. Find the height of the hill.

To recapitulate:

1. Reading is a problem in the teaching of Mathematics.

2. The teacher of mathematics should know and understand the reading process; the special skills needed for mathematical reading; the difficulties in reading encountered by pupils; the abilities and capabilities of their pupils in reading; and specific techniques to use to bring about effective mathematical reading.

3. Like any other skill, reading must be used and practiced to be kept at functional level. The work in reading with high school pupils must be a necessary part of the learning process. ●

A Non-Academic Course

(Continued from Page 124)

settled to avoid referring to their status. They were made to feel, of course, without being too obvious, that they were just as competent as their fellow students in the phys-math groups. This phase of the program was considered of the utmost importance.

What are the plans for the future of this program? One innovation is under consideration; namely, to adopt a standardized mathematics test to be administered sometime around the second semester of the junior year. Our guidance has some unique and sterling ideas concerning this phase of the program. Incidentally, the mathematics test now being considered is the Davis Test of Functional Competence in Mathematics.

I have mentioned student-parent education and reaction. In general, most accepted the program as a plausible solution to the problem. Taking care of the needs of the deficient student in this way has served to remove one of the many hurdles that interferes with the smooth running of a school curriculum. Naturally, anything the teacher does to aid academically undernourished youths comes under the heading of a job Well Done. Central's administration, I believe, is well satisfied with the success of the program thus far. Frankly, I think it is here to stay. ●

Formaldehyde

(Continued from Page 134)

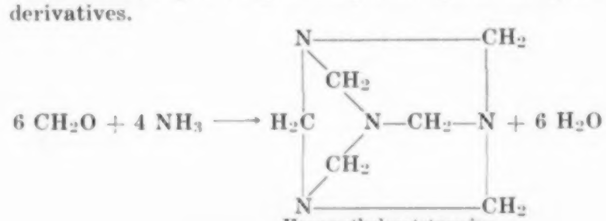
In the presence of an alkali, formaldehyde reacts with aldehydes having an alpha hydrogen to form polymethylol derivatives.

$$CH_3CHO + 4\ CH_2O \xrightarrow{NaOH} \underset{\text{(Pentaerythritol) (P.E.)}}{C[CH_2OH]_4} + HCO_2Na$$

$$CH_3CH_2CHO + 4\ CH_2O \xrightarrow{OH^-} CH_3\text{—}\overset{\displaystyle CH_2OH}{\underset{\displaystyle CH_2OH}{\overset{|}{\underset{|}{C}}}}\text{—}CH_2OH + HCO_2H$$

1, 1, 1 — Trimethylolethane (TME)

Pentaerythritol is extensively used in the preparation of alkyd resins. Ammonia and amines condensed with formaldehyde to give simple or cyclic methylene derivatives.



Hexamethylenetetramine

The reaction of a secondary or primary amine hydrochloride salt with formaldehyde and a compound con-

taining active hydrogen is known as the Mannich reaction.

$$C_6H_5COCH_3 + (CH_3)_2NH_2^+ Cl^- + CH_2O \longrightarrow C_6H_5COCH_2CH_2N(CH_3)_2H^+ Cl^- + H_2O$$

The Prins reaction involves the reaction of formaldehyde with the double bond of an alipathic hydrocarbon to form a glycol.

$$CH_3CH = CH_2 + CH_2O \xrightarrow[H_2O]{H^+} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-CH_2OH$$

(1, 3 Butylene Glycol)

The reaction is usually carried out in the presence of acetic acid which results first in the formation of the di-acetate. This may then be hydrolyzed to the glycol.

Formaldehyde and acetylene react (Reppe Reaction) to yield 2-butyne-1,4diol and propargyl alcohol.

$$C_2H_2 + 2CH_2O \longrightarrow \underset{\text{(Butynediol)}}{HOCH_2C \equiv CCH_2OH}$$

$$C_2H_2 + CH_2O \longrightarrow \underset{\text{(Propargyl Alcohol)}}{CH \equiv CCH_2OH}$$

Formaldehyde is one of the major organic chemicals manufactured in the world. It is used in the preparation of almost every type of paint, in the manufacture of your telephone and your plastic dishes. There is hardly an organic chemical industry that does not use formaldehyde somewhere in its manufacturing processes. Today no home is without plastic articles made with formaldehyde. ●

Municipal Purchasing

(Continued from Page 114)

is used to prepare media for the purpose of growing the diphtheria bacillus.

For the protection of the employes at the Highland Park Zoo, who are required to care for the venomous reptiles on display there, we sent all the way to the South Africa Institute for Medical Research, Johannesburg, South Africa, and to the Central Research Institute, Kasauli, Pepsu, India, for concentrated Anti-venom Serum to inoculate against the bite of these poisonous snakes. Even though we obtained delivery by air mail, some three months were required to complete the purchase, delivery of the serum being made in care of the Collector of Customs for the purpose of inspection.

Internal trouble in China cuts off the flow of hog bristles and the price of paint brushes used in our paint shop goes up. A brush that cost $70.00 a dozen a few years ago will now cost as much as $160.00 a dozen. We have never found a satisfactory substitute for the burlap sheet that is used by the employes of the Incinerator in picking up the daily accumulation of rubbish. When the supply of the raw material from India is cut off the cost of the sheet goes up from a normal of 44¢ to $1.72 per sheet.

To maintain the city's automotive fleet, consisting of 938 pieces, we expend $100,000.00 annually for parts

and $185,000.00 for gasoline. We are constantly replacing old equipment and in the course of a day we may buy, at a cost of $34,000.00, one of the long, red aerial trucks that answers the alarm of a fire, and on the same day order the little cart you see the street-cleaner pushing along the curb. These now cost us $125.00 each.

It is indeed a rare day that fails to produce something interesting or amusing such as the morning the new girl appeared before the Director with a horrified expression on her face. She had just opened the first lot of requisitions and found one marked with a big red "RUSH!" "I must have a case of toilet soap at once. I have thirteen white legs to wash." It was only the Superintendent of the city stables who wanted his horses to look their best in the street parade. ●

★ ★ ★ ★ ★

The Family of Brasses

(Continued from Page 126)

There are a number of other brasses to which small quantities of one or more elements are added for specific purposes. The addition of about one per cent of tin to Cartridge Brass produces Admiralty, long used for its resistance to saltwater corrosion. When approximately one per cent tin is added to Muntz Metal, the result is Naval Brass which has an increased corrosion resistance and is slightly harder. The addition of small amounts of tin, iron and manganese to Muntz Metal produces Manganese Bronze which is a much harder, stronger and more corrosion resistant alloy than the former. Similarly, the addition of about two per cent aluminum to a mixture of approximately 76 per cent copper and 22 per cent zinc results in a highly corrosion resistant alloy—Aluminum Brass. These small quantities of other elements added to the brasses produce highly significant changes in the physical and mechanical properties of these alloys.

Generally, these alloys are available in most of the regular commercial forms enumerated previously. Their uses, however, are somewhat specialized and confined largely to industrial applications where more or less severely corrosive conditions must be resisted. For example, Aluminum Brass is widely specified for condenser, evaporator and heat exchanger tubes and distiller tubes. Naval Brass is used for propeller shafts, marine and aircraft hardware, valve stems and condenser plates.

Another group of alloys in the family of brasses is the Nickel Silver series, which might be considered in the category of "cousins." In these alloys nickel is substituted for part of the zinc, otherwise it is a true copper-zinc alloy and is generally classified as a brass. Nickel Silver is a silver-colored alloy with good strength, extremely good corrosion resistance, and has good hot and cold working properties. These alloys usually carry a designation consisting of two numerals

which indicate the percentage of copper and nickel, respectively. For example: Nickel Silver, 65-18; Nickel Silver, 65-15; Nickel Silver, 65-12; and Nickel Silver, 65-10.

These alloys are available in practically all commercial forms, including sheet, plate, strip, rod, wire and tube. They have a host of applications, some of the more important being for flat and hollow tableware, costume jewelry, optical goods, zippers, camera parts, surgical and dental instruments, hardware, automobile and marine trim, fixtures and springs.

Actually, it would require a volume to discuss all of the important and interesting applications of the alloys comprising the family of brasses in industry, communication, transportation and building, in fact, in every phase of modern life. ●

★ ★ ★ ★ ★

Colloids Out of the Sea

(Continued from Page 117)

Agar, the typical hydrocolloid found in one group of red seaplants, has one sulfate for approximately each twenty sugar units. Boiling water is required to dissolve agar to form a fluid solution which sets sharply to a firm gel on cooling to the same low temperature each time, regardless of concentration or other solutes. Melting of the gel requires the same conditions as solution of the original agar. These properties, together with the low concentrations required for gelation (one per cent in water forms a firm gel), make agar unique. For solid bacteriological media no other gelling agent has such an ideal combination of physical properties, coupled with a relative inertness to microbial attack and lack of reaction with other colloid systems.

Carrageenin, at the other extreme, has one sulfate for each sugar unit. Solutions are very viscous and gelation characteristics are dependent on other solutes which determine gelling temperature and gel strength. Of particular significance in regard to gelation are potassium and ammonium salts which can be used at relatively low concentrations to regulate the gel function. Unlike agar, carrageenin gels melt at a temperature only slightly higher than that at which they set. Although similar to agar in resistance to microbial attack, carrageenin is a more reactive hydrocolloid, readily forming complexes with soluble proteins and other positively charged macromolecules.

Intermediate between agar and carrageenin is a closely similar group of hydrocolloids which have had relatively little study and as yet have been given no group name. In the hope of getting better acquainted, let us coin the name "gelin" from "gelose," the common name of all red seaplant hydrocolloids, and "intermediate" because of its group position.

Gelin has a sulfate content, estimated from the meager data available, midway between that of agar and carrageenin. The physical properties also seem to assume an intermediate position. Solution viscosity is low compared to carrageenin, but higher than that of agar. Gel strengths are betwixt and between but control of the gel function, as with carrageenin, is

dependent on other solutes, the same relative activity being observed.

As would be expected from the lower charge density arising from fewer sulfate groups, complexing reactions with proteins are not as intensive as those observed with carrageenin.

Diametrically across carrageenin from gelin in properties is a fourth known group of hydrocolloids. Also hitherto unchristened, let us invent for this group the name "viscin," which I believe we shall not find inappropriate. For although viscin has at least the same degree of sulfation as carrageenin, the viscosity of viscin solutions is greater than that of carrageenin at similar concentrations. Viscin has almost no tendency to gel and is but weakly affected by those salts that affect gelin and carrageenin so markedly. As a complexing agent for positively charged macromolecules, it is the most powerful yet known.

Counting up the booty of this treasure hunt, we find three rapidly growing pearls, agar, algin, and carrageenin, and two seed pearls, gelin and viscin, any one or all of which, with but the proper stimulation, can exceed man's fondest dreams in value. The stimulation comes from constant search and research. ●

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Human Blood Derivatives

(Continued from Page 115)

released by Armour's Control Department, The National Institutes of Health and The Research Council, it is packaged and shipped. The packaged albumin is rushed to the Army and Navy for use in Korea and the different veterans' hospitals in the United States. The gamma globulin is shipped to the various state health departments, according to the extent of polio epidemics.

For fractionating 18,000 pints of blood a week, it is definitely necessary to have large type equipment. This must include 275 tons of refrigerant daily, two cold rooms which contain 3,600 square feet of floor space plus 1,200 square feet of mezzanine. De-ionizers and distillation stills for pyrogen-free water, and distillation stills for recovery of alcohol, are in production twenty-four hours a day to help keep a source of pyrogen-free water and alcohol. Twenty-nine centrifuges, ranging in speed from 15,000 to 24,000 revolutions per minute, are used twenty-four hours a day, seven days a week.

Armour has installed twenty-three glass-lined jacketed tanks. These tanks have fast-moving agitators and specially constructed temperature controls that take care of any heat reaction that is generated in the solution during the addition of the reagents. We employ thirteen 1,000-gallon, four 500-gallon, and six 300-gallon tanks. In addition to these, we have over thirty 50- and 100-gallon portable tanks. We have specially designed 25-gallon tanks that can be sterilized and used to receive sterile concentrates. Special packaging and labeling equipment is included in this list of necessities.

The 18,000 pints of blood will yield at least 1,350 gallons of plasma, which produces approximately 4,500

100 cc. vials of albumin, and 10,000 vials of 10 cc. units of gamma globulin.

Testing for protein concentrations, pH, alcohol concentrates, turbidity, is a 24-hour-a-day operation in a specially designed laboratory. Of course, to operate this equipment it takes chemists, bacteriologists, processing technicians, supervisors and laborers. These people must be trained in the use of this equipment and in this process.

A special breed of white mice is used for testing the poliomyelitis. White rabbits are used in the pyrogen test, and guinea pigs are used for safety and toxicity tests. The special antibodies titration for polio, diphtheria, and infectious hepatitis, takes 21 days of careful control.

The over-all time consumed with continuous operation in the processing, testing and filling is approximately twelve weeks, from the time the bleedings are received. This means that for at least twelve weeks someone is continuously engaged in getting these bleedings processed and into gamma globulin and albumin and ready for shipment.

The blood derivatives is only a small part of the operations at Armour's new laboratory. Mr. H. C. Johnson of Armour's in Chicago is Manager of the plant and Director of the Blood Program. Mr. R. C. Johnson is Superintendent of the Kankakee plant. Mr. J. R. Fisher is Associate Director of Blood Derivatives Program. ●

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